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ENGINEERING • CONSTRUCTION • OPERATIONS

PIPE LINE INDUSTRY

MARCH
1959

Publishing Company, 1959

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SPECIAL CORROSION REPORT

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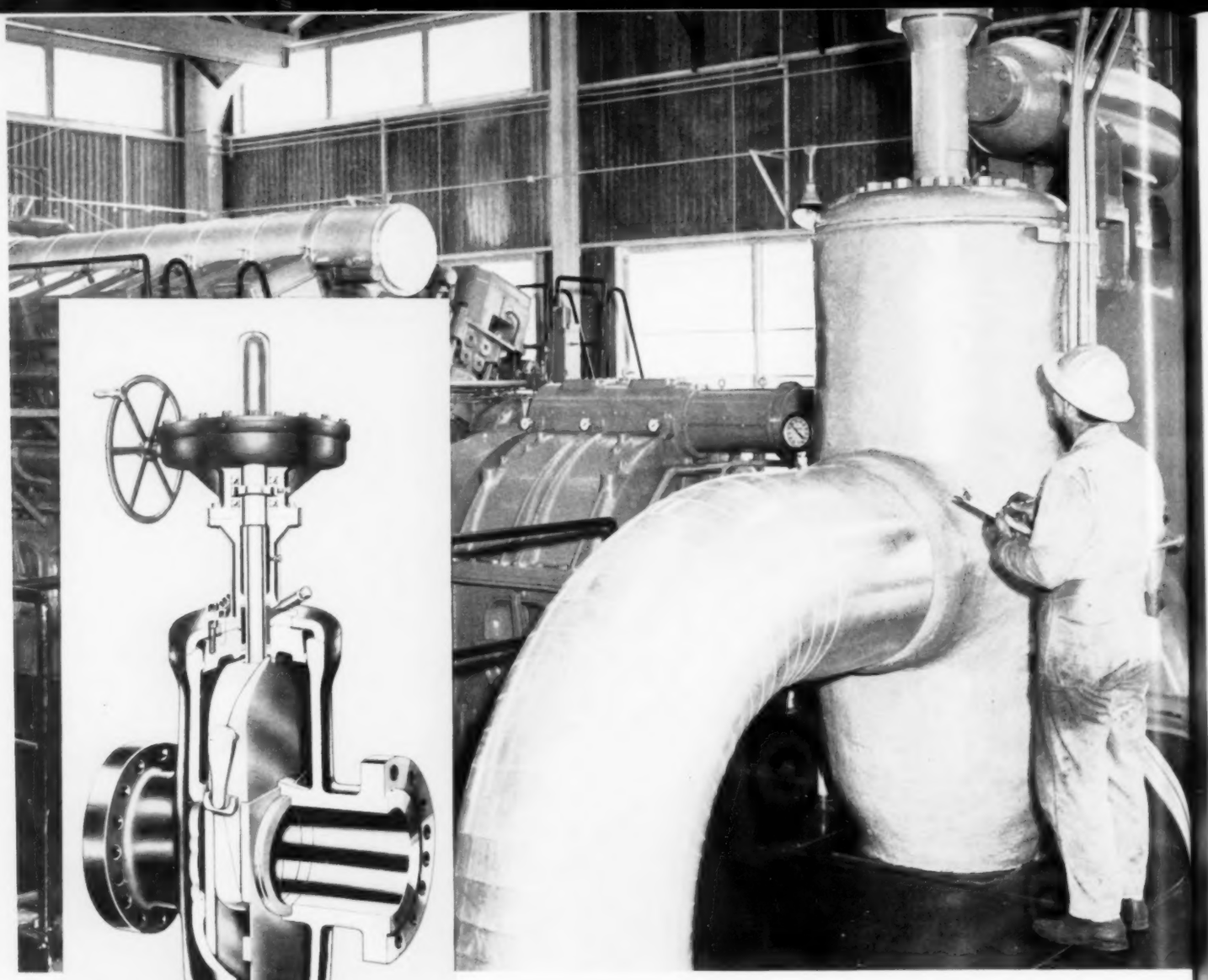

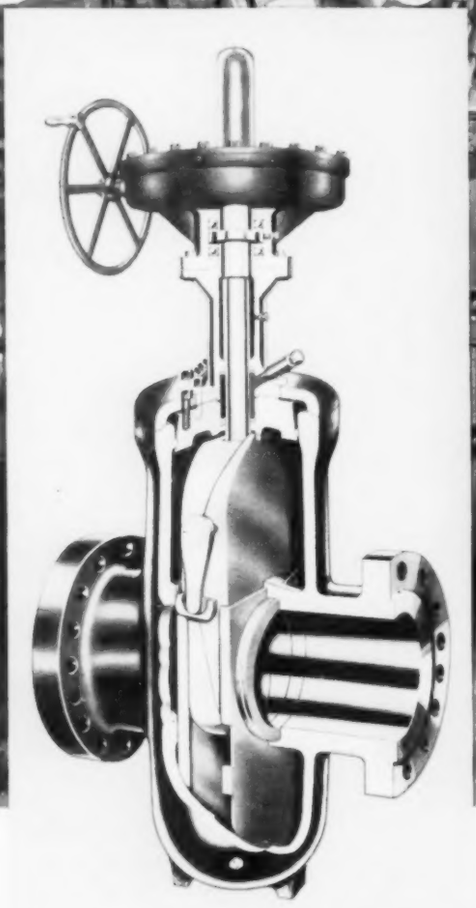

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No other pipeline valves are so carefully engineered to meet the practical requirements of pipeline service. No other valves will give you the same performance, the same long life, the same long-range economy. No other valves can be so easily or quickly overhauled "on-the-line."

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PIPE LINE INDUSTRY

March, 1959 Vol. 10, No. 3

CONTENTS and Quick Look

To help you put first things first, scan these time-saving digests, checking ☑ those you want to read first.

Calcareous Coatings—the Corrosion Engineer's Offshore Ally

☐ When high density current is impressed on offshore structures, calcareous deposits form on the bare steel. This scale has many desirable characteristics; it provides a fair degree of protection in itself, while healing imperfections in coating. In one instance, where the coating on a 12-mile line was severely damaged, high density current was used to repair the coating—building up an "electrocoating" on the damaged areas. Savings in the cost of re-laying the line ran into hundreds of thousands of dollars.

By Donald M. Taylor.....Page 36

How to Design Impressed Current Systems—Part 1

☐ In sizing and locating cathodic protection rectifiers along a pipe line, the engineer often finds a simple problem in theory becoming very complex in practice. Deciding how many rectifiers to use and where to install ground beds requires sound engineering and an evaluation of economics. This first part of a comprehensive cathodic protection design "handbook" covers attenuation factors, influence of pipe size and coating condition. The concluding part following next month will shed more light on these subjects, plus a look at effects of soil resistivity and practical field conditions.

By James C. Bell.....Page 40

Tough New Coating Can Be 'Tailored' to Fit

☐ Polyepoxy resin—a combination of coal tar, diepoxy resins and polyurethanes—is proving highly versatile. Its hardness, flexibility, resistance to chemical corrosion and mechanical abrasion can be controlled to a surprising degree. In addition, it exhibits freedom from deformation and flow at elevated temperatures and retains high impact resistance at low temperatures. Its developers say it approaches the quality of a baked-on coating.

By W. E. Kemp.....Page 48

Advances in Rectifiers Solve Protection Problems

☐ The number of problems that can be solved by proper use of rectifiers is surprising. For instance, simple half-wave rectifiers make it possible to have reliable protection from stray currents by bonding to stray DC sources without depending on automatic switches. Moreover, they make it possible to put stray AC current to work and protect a line with it. New developments in rectifiers—selenium stacks and silicon diodes—make considerable savings possible through minimizing the number of rectifiers used to do a job.

By Troy R. Stilley.....Page 51

Keeping Up With the Pigs

☐ Radioactive tracers provide the best means. But there are precautions to be observed both in handling and running the "hot" tracer pigs. Special tools are required for insertion and removal of the "source". When it hangs up on an obstruction, it can be located with pinpoint accuracy, even under 6 to 8 feet of backfill.

By William T. Theis.....Page 56

Supervisors 'Go Blind' for Safety

☐ There is no doubt that one of the best ways to realize the value of sight is to experience the helplessness which accompanies "going blind." Here's how Esso Research and Engineering is impressing that fact on its supervisors. You'll enjoy this fast-reading picture story.

By Howard Kempsell.....Page 58

Ideas for the Future.....Page 60

Have You Seen This Man?

WE'RE LOOKING for a certain fellow on the sunny side of 40. You'd consider him a personable sort, though he doesn't flash his dentures at the drop of a pun. He's got a lively curiosity, likes to travel, and he likes people. He went to college . . . studied engineering . . . but he didn't stay there so long he became a campus institution. Someone who has some pipe line experience. He has a nodding acquaintance with a typewriter. Not necessarily a polished writer, you understand. Just a fellow who can put one word after another and come up with something a pipeliner will like to read.

Have you seen this fellow? Well, if you happen to run across him, tell him to get in touch with Mel Judah, the foreman on this spread. Mel wants to offer him a job. The complete name and address is Melvin A. Judah, Editor, PIPE LINE INDUSTRY, PO Box 2608, Houston 1.

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The Same Old Story—20 Years Later

No matter what administration is in office, it is political tradition for the federal government to turn the oil industry on and off like a pipe line valve.

When the nation needs a sudden step-up in production, open the gate. Curb inflation with price ceilings, but let up on federal controls. Stop kicking the political football called depletion, put a temporary lid on anti-trust investigations; and provide every incentive to produce.

When oil isn't needed on an emergency basis, throttle back flow to a dribble. Tighten the screws of federal control. Plague the industry with investigations and anti-trust suits. Cut the industry's throat at every turn for a vote—and discourage incentive to build reserves for another emergency.

The valve has been opened and closed seven times in the past 20 years, and the depletion provision may close it tight again. Oil men can hardly be expected to continue to assume the tremendous economic risks of finding and producing oil when the odds against success are compounded even more by government interference, unwarranted regulation and destruction of incentives during times of peace.

Here is the way the handle has turned in recent years:

Just prior to World War II, the flow was throttled down. Senator Cole (Md.) had introduced a bill to impose rigid federal controls on crude production—the Federal Power Commission was completing plans to place government regulations on natural gas producers—Senator Nye (N. D.) had submitted a resolution that would permit the Senate Judiciary Committee to conduct an investigation of alleged monopoly in the oil industry. Efforts were being made to cut the depletion provision to 15 percent. (The political pattern hasn't changed one iota in 20 years.)

Then came World War II and the urgent need for vast amounts of additional crude supplies in a hurry. The anti-oil political philosophy that was rampant a few months earlier was completely reversed. The valve was turned to full open. "Villain" oil became "hero" oil over night.

Shortly after World War II, the gate again was closed. Politicians returned to their old practice of using the oil industry as a whipping boy whenever votes were needed. The issues were almost identical with those of pre-war days. Only the wording of the bills and some of the politicians' names were changed.

The valve was re-opened for the Korean conflict, though not as wide as before. After Korea, the oil industry was returned to its role of producing more votes, with less incentive to find vital reserves for national defense. The pattern repeated itself during and after the Suez crisis.

Now we are once again enjoying times of peace, if such a label can be given to cold war. Result: With no immediate emergency need for oil, our federal government is desperately seeking ways to meet its skyrocketing financial needs. The depletion provision once again has become a major tax target. Efforts are being made to increase already too-high gasoline taxes. And again comes a threat that the valve will be closed once more.

Will history repeat itself for the eighth time? Or, for the first time in 20 years will the oil industry be allowed to progress naturally during times of so-called peace? Although history refutes a hopeful answer to the latter question, such a situation could be created if the principals involved would:

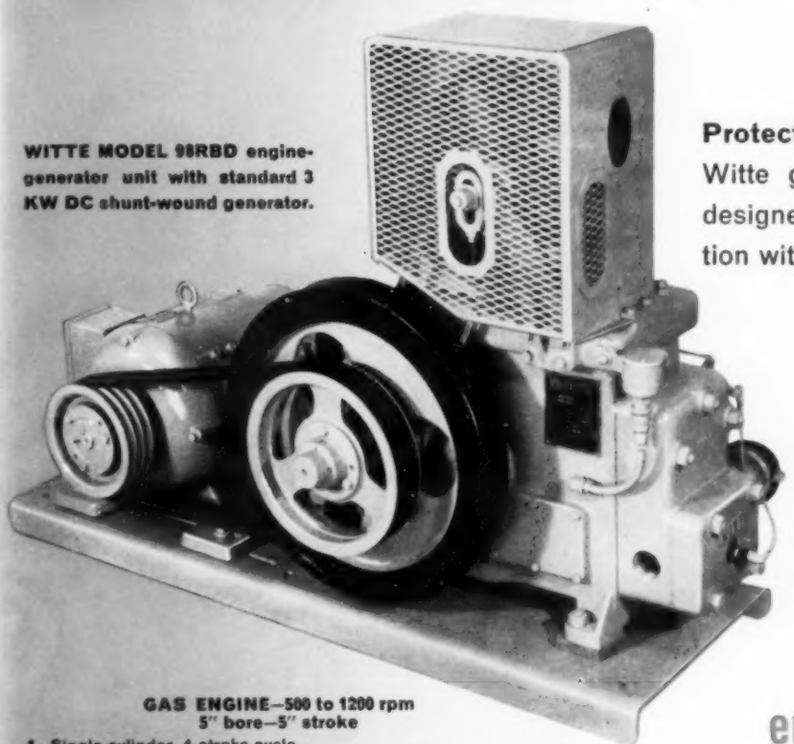
1. Disregard, for once, the shortsighted play for votes and think first of our nation's welfare in terms of future needs and emergencies.
2. Realize that our nation's vital oil reserves can hardly be expected to be replenished without giving oil men an opportunity—in peace, as well as war—to compete in a business climate unhampered by unnecessary federal controls.
3. Act on the above two statements by at least maintaining existing incentives at a time when profit margins are steadily diminishing.

These are the factors necessary for an economically healthy oil industry. They can become a reality, despite history's pattern. But, only if the public and the federal government fully understand, then act on the principles of free enterprise that created a nation with the highest living standards in the world.

It is the responsibility of every person in the oil industry to help the public and federal government to understand the need for proper incentives and the need to permit business freedom with a minimum of unnecessary federal control.

The truth is on our side.

CONTROL CORROSION with WITTE Cathodic Protection Units



WITTE MODEL 98RBD engine-generator unit with standard 3 KW DC shunt-wound generator.

Protect your pipelines at low cost with Witte gas engine-driven generator units, designed especially for continuous operation with minimum attention.

the Witte Model 98RBD engine-generator unit

. . . is built especially for cathodic protection of pipelines. The heavy-duty industrial-type gas engine has been thoroughly field-tested and is the ultimate in strength, simplicity and clean design. It has a low center of gravity, is well balanced, and every part is easily accessible. Built for 'round-the-clock operation, it has condenser cooling, removable wet cylinder liners and roller main bearings. It is equipped for long-run service, having oil make-up reservoir and float valve as well as lube oil and cooling water safety controls. Its wide speed range—500 rpm to 1200 rpm—provides a flexible voltage output.

GAS ENGINE—500 to 1200 rpm
5" bore—5" stroke

1. Single cylinder, 4-stroke cycle
2. Condenser cooling
3. Manual start—hand crank (12-volt electric starting—optional at extra cost)
4. Low water and oil level safety switches (optional at extra cost)
5. Oil make-up reservoir and float valve (optional at extra cost)
6. Fan bearing—grease-packed and sealed
7. Dual flywheels

GENERATOR—750 to 1800 rpm

1. V-belt driven
2. Direct current, shunt-wound, 3 KW
3. 32-40 volt
4. 94 amp. at 32 volts
5. Voltage control to less than 5 volts when generator speed is 750 rpm
6. Ammeter, voltmeter and circuit breaker
7. Splash-proof protection
8. Rodent protection
9. Grease-packed sealed bearing

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Complete information on the **98RBD** *is available by contacting Witte Engine Works*

USS Witte Engines

gas - gasoline **models from 3¾ to 42 hp**
full diesel **models from 3¾ to 18 hp**

Witte Engine Works
Oil Well Supply Division of
USS United States Steel

Offices and Plant, Kansas City 26, Missouri

Mr. M. B. Riordan, Vice President
B. J. Service, Inc., Long Beach, Calif., says.

"Low curb weight, price and maintenance cos

deciding factors in our preference fo Fo

"We've owned Ford Trucks for almost eleven years and find Ford's low curb weight means bigger loads for us. Our Ford T-800's haul up to 1800 lb. more payload than other trucks of comparable size.

"We've been in the oil well business for 31 years supplying the materials, personnel and equipment to do a complete oil well servicing job. We operate 365 days a year and 24 hours a day. With $25,000-$30,000 tied up in each rig, we could lose money fast if our trucks weren't reliable. We feel our Fords do an outstanding job.

"You can't beat Ford in value, either! Not only is Ford's initial price low but we get three years of hard, rough use out of our Ford Trucks before we trade. That way we keep our costs 'way down.

"Maintenance costs are very reasonable, too. Not only are Ford Trucks easier to overhaul but parts costs are lower—our profit and loss statement proved that to us! And we can get Ford parts anywhere we operate. That's important in our kind of work because it's essential we stay on the job once we are started."

anc costs have been

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Go FORD WARD for savings

FORD TRUCKS COST LESS

LESS TO OWN... LESS TO RUN... LAST LONGER, TOO!

NOW!
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by America's foremost independent automotive research organization*
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Send inquiry to: P.O. Box 2687 Ford Division, Ford Motor Co. Detroit 31, Michigan

'59 Ford Pickups Win Economy Showdown U.S.A.

—average 25.2% better gas mileage!

Impartial tests of the 1959 pickup models of all six makes prove conclusively that Ford's ½-ton pickups equipped with Short Stroke Sixes are the economy champs for '59.

HOW TESTS WERE MADE

Standard six-cylinder models of the six leading half-ton pickups first were put through exhaustive road trials. All '59 trucks—Ford and competitive—were bought from dealers, just as you would buy them. After at least 600 miles break-in, all were brought up to manufacturer's recommended specifications.

The trucks were then tested—by America's leading independent automotive testing firm—at constant speeds of 30, 45 and 60 miles an hour. Next came stop-and-go tests, ranging from moderate city traffic to normal retail delivery operation. Acceleration rates were carefully timed in each gear to insure accurate results for all makes.

HOW NEW '59 SIXES RATE IN GAS MILEAGE						
'59 FORD SIXES GIVE	25.2% more miles per gallon than Make "C"	31.1% more miles per gallon than Make "I"	9.6% more miles per gallon than Make "G"	42.6% more miles per gallon than Make "D"	22.0% more miles per gallon than Make "S"	25.2% more miles per gallon than the average of all makes

The '59 Ford Sixes, *in every test*, averaged more miles per gallon than every other make! Combining all tests, the '59 Fords led the average of all other '59 pickups by 25.2%.

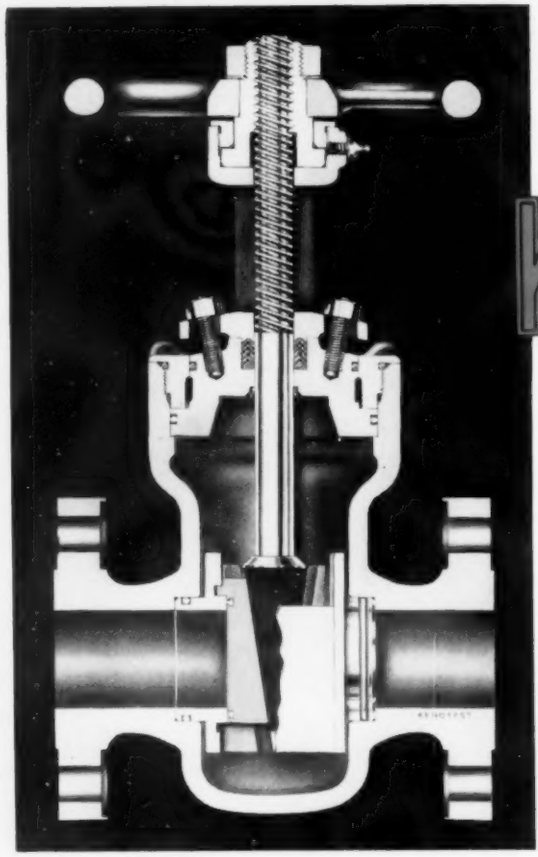
WHAT'S THE SECRET?

How can a '59 Ford Six make four gallons do the work of five in other trucks?

First, of all pickup Sixes, only Ford has modern Short Stroke design. This new type of engine is basically far more efficient than long-stroke Sixes of other pickups. Example: Ford's Six delivers more usable horsepower than any other pickup Six.

Second, to this modern engine Ford has added a new economy carburetor. By metering fuel more precisely in both low- and high-speed ranges, Ford's new carburetor boosts gasoline mileage in every type of driving. And Ford's *Economy Carburetor* is *standard at no extra cost*.

Your Ford Dealer now has the complete report of Economy Showdown U.S.A. Why not call or visit him today and get the whole story firsthand?



Eliminate those costly leaks...

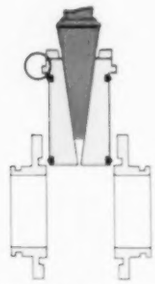
...with the

KEROSEAL® VALVE

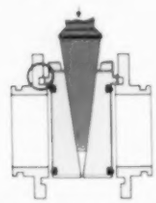
- **bubble-tight**
- **non-lubricated**
- **optional flow**
- **full opening**
- **double block and bleed**

Handles a wide range of liquids and gases in the Petroleum and Petrochemical Industries.

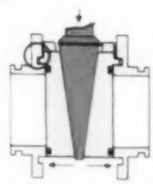
A bubble-tight seal—among other exceptional features—makes the revolutionary KEROSEAL valve an important asset to the gas, petroleum and chemical industries. This seal, effected mechanically and without the use of lubricants, eliminates wear, frictional drag, wiping and consequent galling of seating surfaces. All standard types of operators may be employed, whether handwheel, gear or motor. Write for the KEROSEAL valve bulletin for more information on this versatile new valve.



Valve fully open. In closing, discs and spreader move down, perpendicular to flow.



Discs are positioned without drag across seat. When disc lug rests on seat ring, continued downward motion of spreader moves discs parallel to flow.



Valve fully closed. Spreader holds discs bubble-tight against seat rings. When opening, seated discs are retracted with the same parallel motion—again with no drag against seating surfaces. The upward motion does not begin until discs are clear of seat ring.

KEROTEST

KEROTEST MANUFACTURING COMPANY

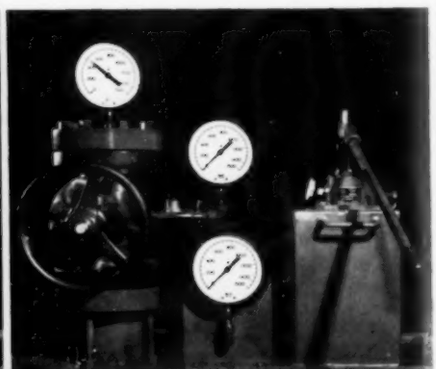
2512 Liberty Avenue, Pittsburgh 22, Pa.

In Canada, Kerotest products are manufactured and distributed exclusively by Guelph Engineering Company, Guelph, Ontario.

Demonstrating effectiveness of upstream and downstream seating on KEROSEAL Valves—with end flanges blanked and valve fully opened—pressure built up (hydraulic oil)—Figures 1-2-3 follow.

The valve was closed, resulting in three separate pressure chambers; i.e., body cavity between seats and two port cavities.

Pressure released in body cavity (center gauge now reads zero). Pressure remained constant in each port cavity.



Pressure released from bottom port cavity of valve. Top port cavity remains at constant pressure.

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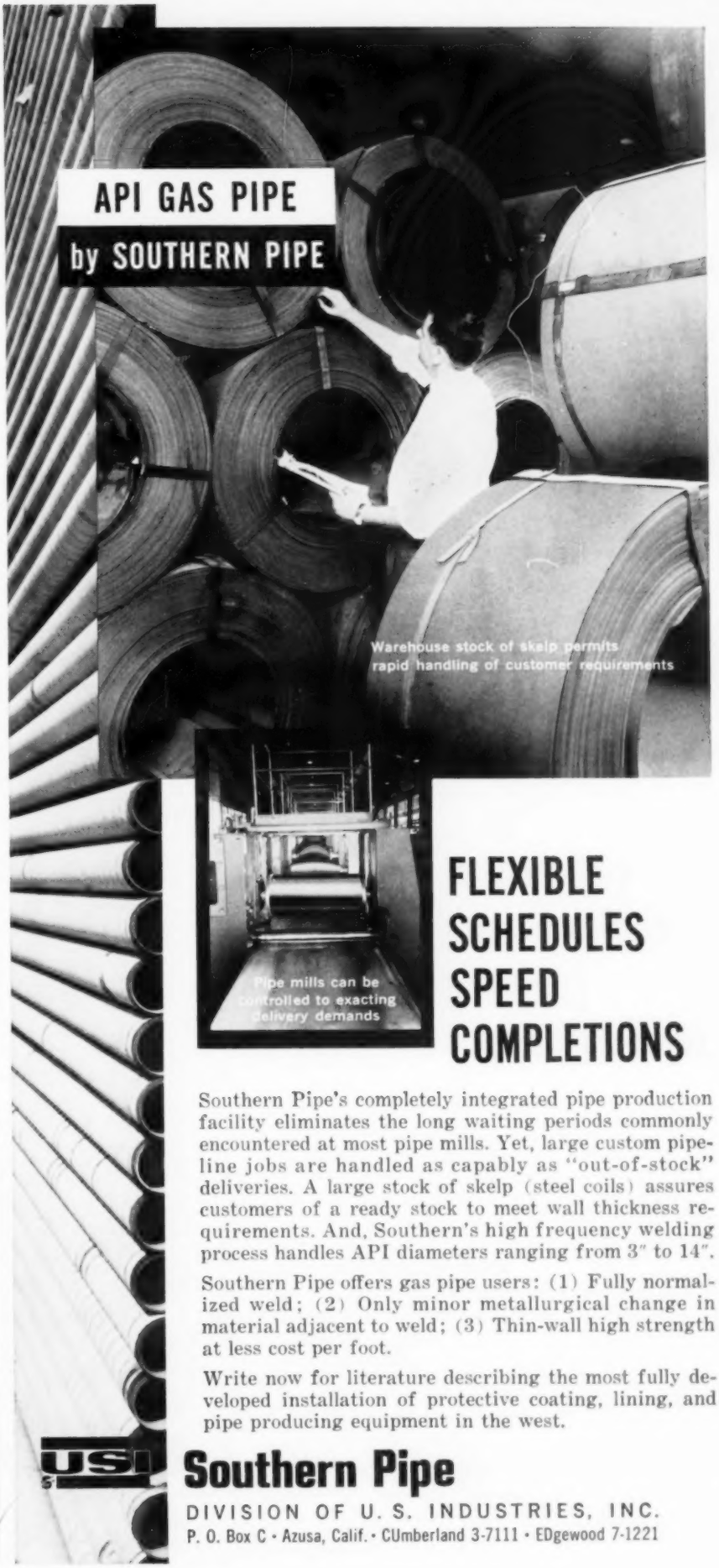
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by SOUTHERN PIPE
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Pipe mills can be controlled to exacting delivery demands
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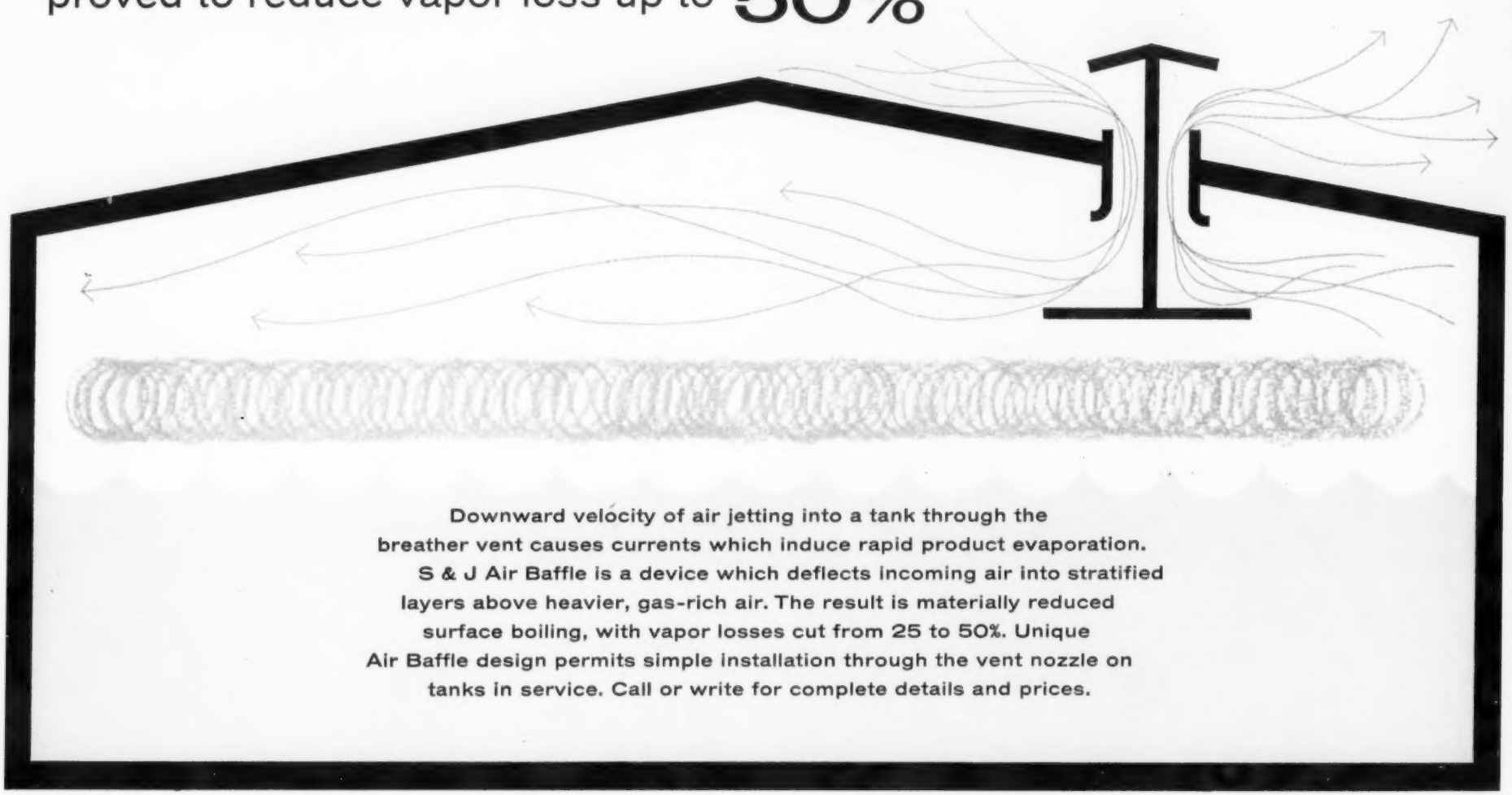

Downward velocity of air jetting into a tank through the breather vent causes currents which induce rapid product evaporation. S & J Air Baffle is a device which deflects incoming air into stratified layers above heavier, gas-rich air. The result is materially reduced surface boiling, with vapor losses cut from 25 to 50%. Unique Air Baffle design permits simple installation through the vent nozzle on tanks in service. Call or write for complete details and prices.

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MORE OF THE GARLOCK **2,000**

Garlock Metal Packings (above) prevent escape of air or gas from compressors. Sets are supplied with segmental packing rings (right) super-finished to 15 micro-inches or less for better sealing.

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2. Gas tight seal between packing rings and packing groove.
3. Packing must not be affected by operating conditions.
4. Operating conditions must not be affected by packing.
5. Packing must have no adverse effect on compressor rod.

Get these fine features by specifying Garlock metal packings. Choose from many different styles and materials. Whichever you select, you can be sure of the finest metal packing available for air and gas compressor service.

Metal packings and oil scraper rings are more of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. Assure yourself of the proper application by discussing it with your local Garlock representative. Call him, or write

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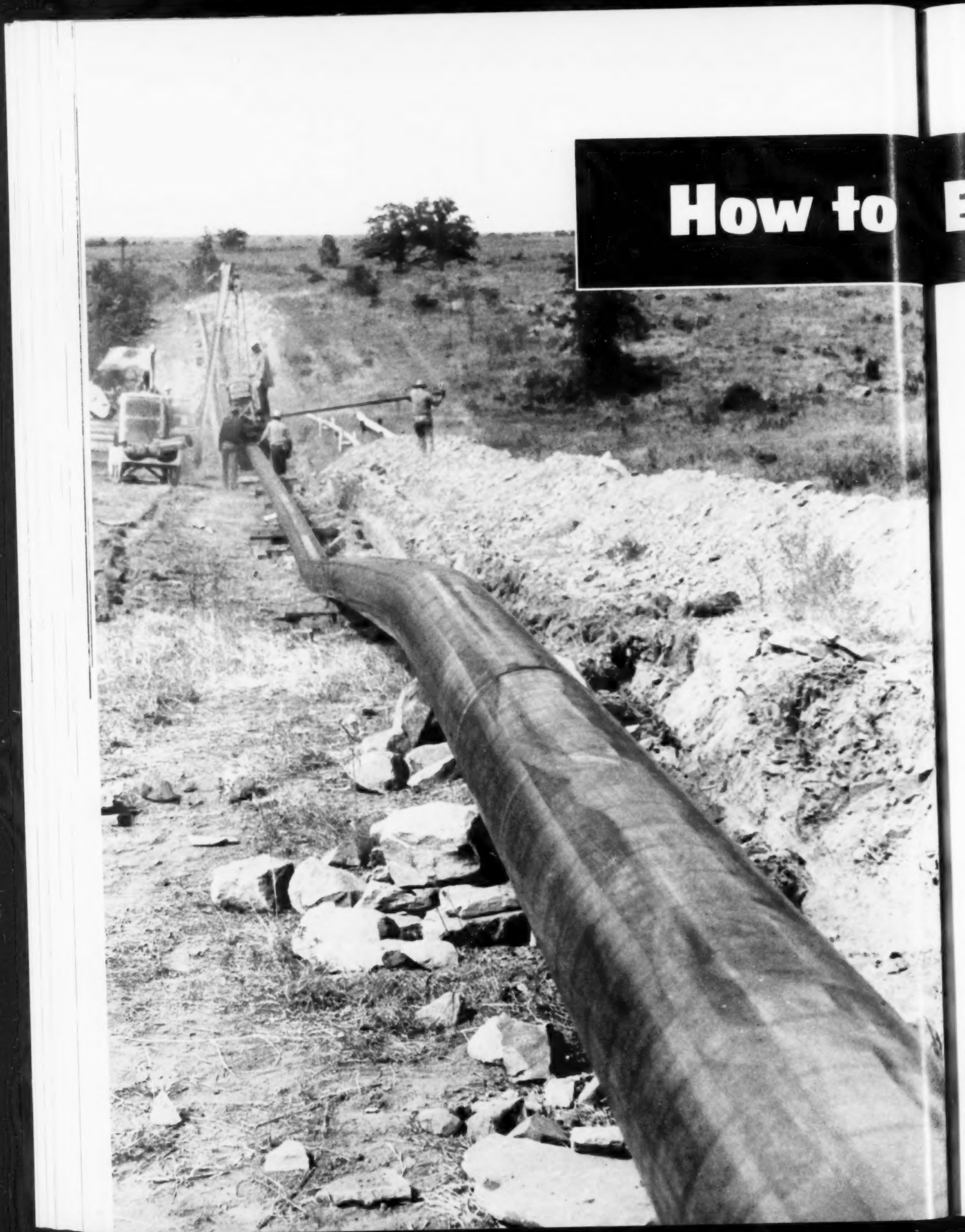
How to

Expedite a Pipe Line

J&L Electricweld line pipe is uniformly round. Wall thickness is constant. It lines up quickly, welds readily, and bends safely to any reasonable course. Lengths to 60 feet minimize field welds.

All J&L line pipe is finished and tested to meet ASTM and API specifications. **Electricweld** is furnished in sizes from 6⅝" through 12¾" O.D. Seamless line pipe in sizes 2⅜" O.D. through 14" O.D. is also available.

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Photo shows a line of coated and wrapped J&L 12¾" O.D. Electricweld being laid in Oklahoma.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

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It's the best available

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C. E. Williams, Gulf Sales Engineer, Midland, Texas, and G. W. Ramsey, Assistant Plant Superintendent, inspect force feed lubricators on one of the modern gas engines at the Goldsmith plant of El Paso Natural Gas Company.

No lubrication problems in 8 years of operation

Since 1949, twenty-seven gas engine-compressor units developing 39,985 horsepower at the Goldsmith plant of El Paso Natural Gas Company have been thriving on Gulf Security Oil. Bearing, ring and cylinder wear maintenance records have been excellent.

Insure safe, more effective lubrication protection for *your* compressor units. Specify Gulf Security . . . the high quality, straight mineral oil. For full information, call your nearest Gulf office.

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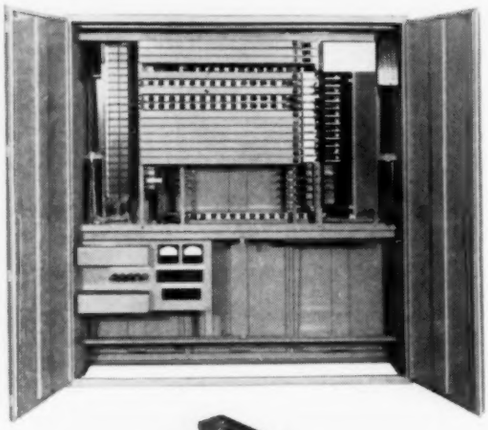
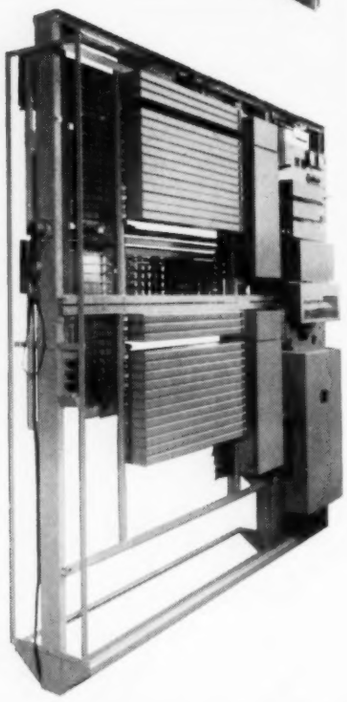
LEASE YOUR OWN TELEPHONE SYSTEM WITHOUT CAPITAL INVESTMENT





Illustrated are two of many possible "packaged" systems. We supply systems engineered to meet any requirements. Capacities range from 10 lines up.

Without tying up a penny of capital funds, you can have a Stromberg-Carlson telephone system to meet the communication needs of your modernization program. Our unique *lease plan* makes it possible.

Why have your own telephone system?

The basic reason is *efficiency*. Stromberg-Carlson dial switching systems (with trunks and/or tie-lines) provide fast, trouble-free communication. You have a wide choice of attended or unattended systems with any capacity you need.

XY® Dial systems operate through step-by-step universal switches tested and proved by many years of service to the independent telephone operating industry.

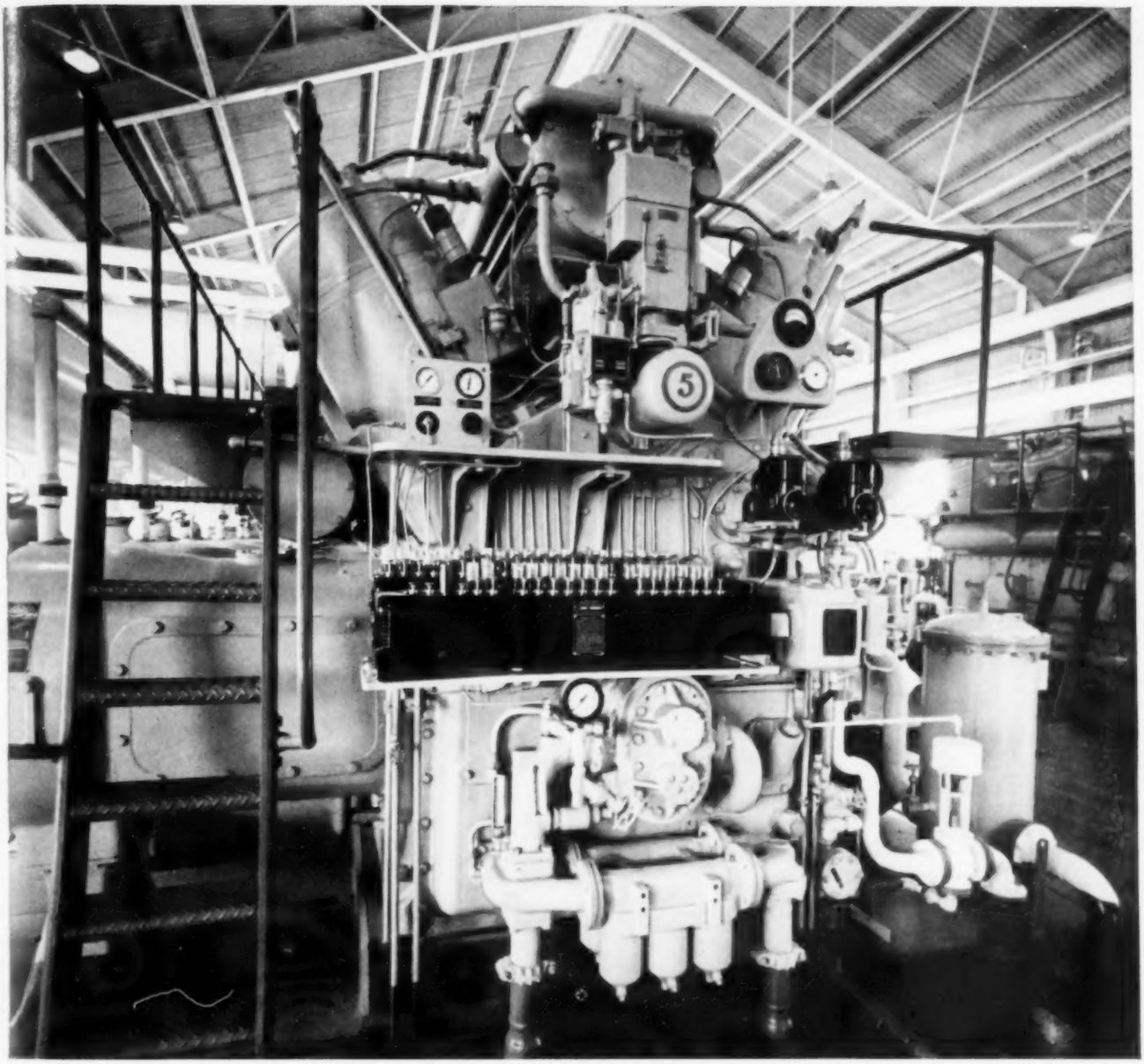
Accessory equipment available includes: voice carrier; telegraph carrier; voice frequency repeaters; multiplex; four-wire data and telephone switching systems; telephones; telephone receiver-amplifier; tone signaling units; tie-trunk concentrating equipment.

Delivery is fast. Service is available from our field engineering staff. Write for literature on the operation of our equipment, types available, plus full details on our lease plan.

STROMBERG-CARLSON A DIVISION OF GENERAL DYNAMICS CORPORATION

Telecommunication Industrial Sales • 127 Carlson Road • Rochester 3, N. Y.

S-C | GD



BENDIX MAGNETOS SPARK COOPER-BESSEMER ENGINES FOR EL PASO NATURAL GAS

Once again, Bendix* ignition equipment is proving its worth to the petroleum and natural gas industries. Shown here is a Bendix LAR magneto and Hi-V transformer coil installation at El Paso Natural Gas Company's Blanco Station in San Juan County, New Mexico. El Paso uses eight 1350 hp. Cooper-Bessemer gas compressors, all equipped with Bendix magnetos, at its mainline gas booster station.

Bendix LAR magnetos deliver dependable ignition at the lowest practicable cost. Even under the most adverse operating conditions, their reserve power ensures smooth engine performance. The Bendix LAR magneto and Hi-V transformer coil form a matched ignition system to handle rugged engine requirements.

LA magnetos now in service can easily be converted to the modern Bendix LAR type with conversion kits now available. They can be obtained from your Bendix ignition distributor or from the factory. For complete details, write SCINTILLA DIVISION OF BENDIX AVIATION CORPORATION, Sidney, New York.

*REG. TRADEMARK

Scintilla Division
SIDNEY, N. Y

Bendix
AVIATION CORPORATION

For more data on advertised products, use Readers' Service Cards, last page.

Putting the Laurel to bed

That's The Laurel Pipe Line! *Recently completed, this 440-mile line is the first to use 24-inch-diameter pipe in a major cross-country refined products system.*

Gasoline and other petroleum products will be transported through the line from Delaware River Valley refining centers to inland marketing areas such as Reading, Harrisburg, Pittsburgh and Cleveland.

National Tube supplied the pipe for the Laurel Line—approximately 66,000 tons of USS National Seamless and Electric Weld Line Pipe in sizes 24" O.D. to 14" O.D. for the main line and 9,000 tons for feeder lines, take-offs, and terminal facilities.

The eastern section of the main line, some 135 miles, is 24" diameter, API 5L X-52 pipe, ranging from .281 to .375-inch wall thickness. Initially, the line's throughput is expected to be about 100,000 barrels a day; however, this can be increased to 300,000 barrels with additional pumping stations. This line will make a greater variety of refined products available, in increased quantities, at a considerably lower transportation cost.

The Laurel Pipe Line represents another first for USS National Line Pipe. Why is USS National consistently chosen for rugged line pipe assignments? The answer in a word: *Performance.* You see, National Line Pipe combines the qualities of strength and dependability to give you a better product. Remember, too, that National Line Pipe is available in a complete range of wall thicknesses, steel analyses and in diameters up to 26 inches in Seamless and up to 36 inches in Electric Weld. For more information, write to National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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National Tube Division of USS United States Steel

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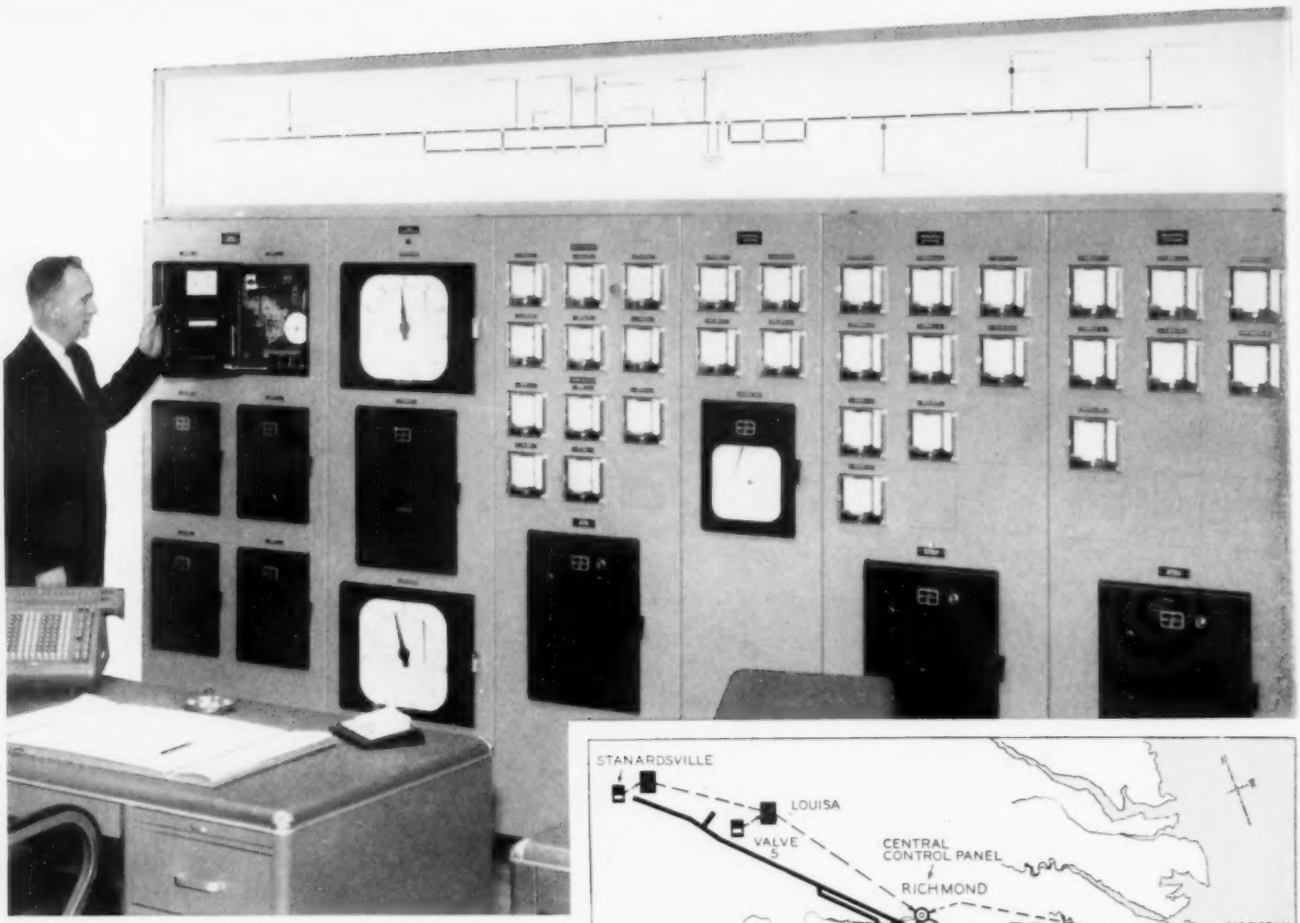
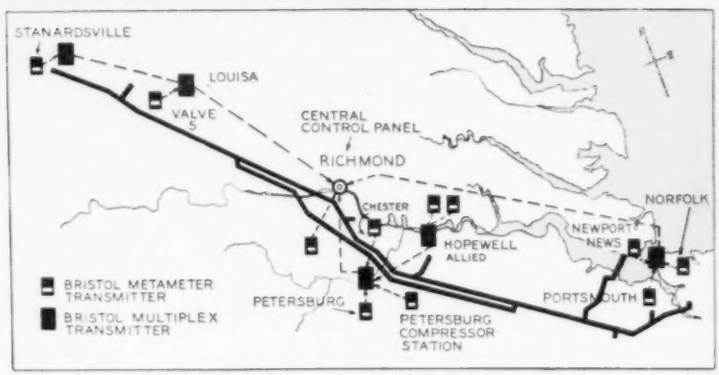




Schematic in top panel shows 300-mile pipeline system controlled by 31 Bristol miniatures, 13 full-sized Bristol instruments below. Map shows system ranging from Stanardsville in Northwest to Norfolk in Southeast Virginia.

Dispatcher's-eye view of a complex 300-mile pipeline system

From this panel of Bristol Metameter* telemeters, dispatchers at the Commonwealth Natural Gas Corporation of Richmond, Va., monitor natural gas supplied to the City of Richmond, The Petersburg and Hopewell Gas Company, The Virginia Electric & Power Company in Norfolk and Newport News, The Portsmouth Gas Company and several large industrial users, and also control the operations of the corporation's compressor station near Petersburg.

In addition, a computing system calculates, records and integrates the flow of gas and automatically corrects for pressure, temperature, specific gravity and supercompressibility so as to aid the dispatcher in approaching but not exceeding the demand figure. Flows, pressures, temperatures and specific gravity are continuously telemetered from critical points along the line. This Bristol telemetering system incorporates both direct wire and multiplexing systems, and uses both full-sized and miniature instruments. Bristol's complete line enables users to select the most economical and efficient unit for each specific application.

Advanced Bristol telemetering and centralized control increases reliability, steps up efficiency and reduces operational costs on any gas system. To find out how, write: The Bristol Company, 114 Bristol Road, Waterbury 20, Conn. B.36

USES NEW BRISTOL MINIATURE METAMETER* TELEMETER RECEIVERS

The miniature Metameter Receiver permits centralized recording and indicating of a large number of variables in a minimum space—presents a uniform, pleasing, easy-to-read panel appearance—measures only 5" x 5⅛", records on a 3" chart (indicating model has 9" scale), fits into 4 9/16" square panel cutout.

*T.M. Reg. U.S. Pat. Off.

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Underneath the handsome bead of a well worked weld, catastrophe is often hidden. Catastrophe that means the possible loss of millions of dollars in man hours and materials should a flaw go undetected.

And the detection of flaws in welds through X-ray is a process that depends on human inspection to properly interpret the delicate tones deposited on X-ray films. That's why a film that gives strong gradation of even the subtlest imperfections makes the job of detection easier and surer.

Ansco X-ray films ***have*** the necessary characteristics for this crucial work. That's because Ansco films are designed especially for this purpose. Higher speed, greater contrast, easier to read means money saved on inspection jobs. Ansco X-ray films are actually more economical because of this. The best you can get is Ansco, and the best is what you must depend on to reveal a possible "hidden catastrophe."

Ansco, Binghamton, New York. A Division of General Aniline & Film Corporation.

Hidden Catastrophe

Ansco

Industrial X-ray

your key to access under pressure... ANY TIME!

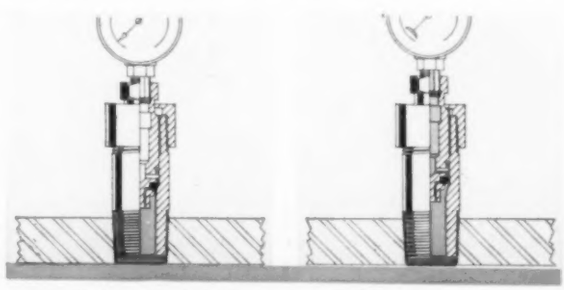
WHETHER IT'S oilfield production, refinery or pipeline application, the Cosasco Access Fitting is your key to entry against pressure—any time! With Cosasco Access Fittings you can seal off outlets but retain gaging or testing capacity... remove or replace valves or other externals... insert instruments, coupons, samplers, thermocouples and hydrogen probes without interfering with normal operations.

HOW IT WORKS. The Cosasco Access Fitting consists of three parts: a low-carbon stainless steel (Grade 303) *gage carrier plug*, a high-carbon steel *body* and a *safety ring*. In closed position (see illustrations at right), the plug primary seal presses against the tapered seat of the body, effectively blocking the flow of gas or fluid. In open position, the plug is backed off until it shoulders against the safety ring. This lifts the plug straight up from its seat and admits pressure—*but very little volume*—past the primary seal. Blocked by the O-ring secondary seal, the gas or fluid enters the plug through the by-pass holes for direct contact with gage or other external equipment.

ACCESS UNDER PRESSURE. By means of a special tool—the Cosasco High-Pressure Retriever—the gage carrier plug can be removed from the Access Fitting *under full operating pressure*. This enables the operator to gain access at will.

SAFETY. The Cosasco Access Fitting is the ultimate in safe devices for pressure readings. Only a minute volume of gas or fluid is ever admitted to the gage... yet accuracy is in no way impaired. Cosasco Access Fittings have a rated working pressure of 10,000 psi... are being successfully used at pressures in excess of this figure. Only 78 ft/lbs of torque are required to operate the gage carrier plug under 10,000 psi pressure, and the only tool needed is a standard box wrench.

FREE CATALOG. New 32-page catalog covers Cosasco's complete line of access fittings, including applications for oilfield production, wellheads, fracturing, drilling and corrosion surveys. Write for free copy today. Or send details and blueprints and let Cosasco Engineering Dept. solve your particular access-under-pressure problem.

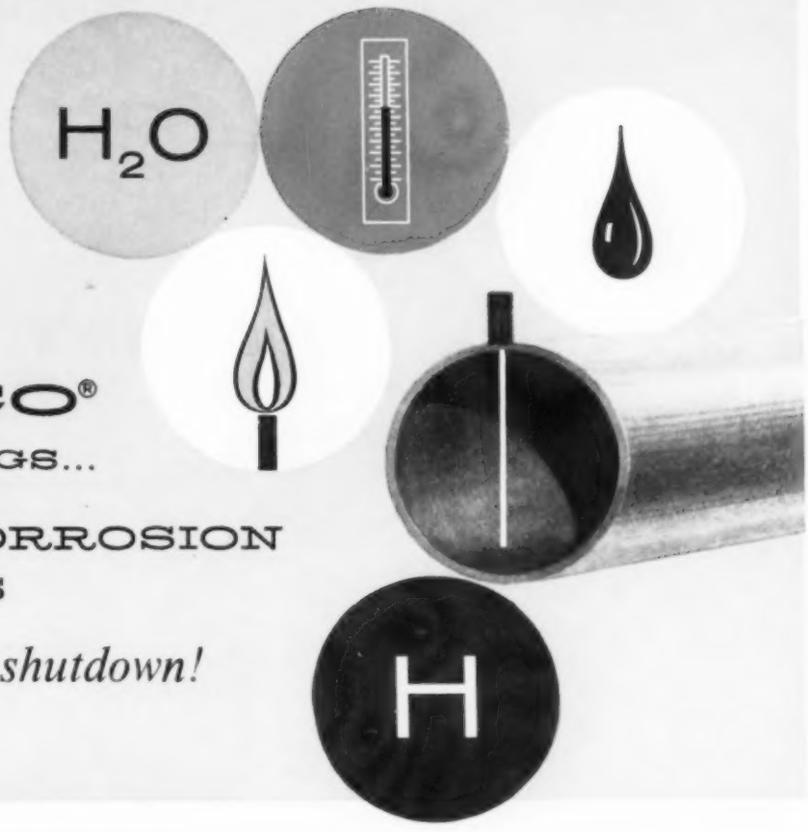


Access Fitting closed. Primary seal in position against tapered seat of body. Plug is never in contact with body except at straight threads... is protected from pressure, fluid, distortion, wear at all times.

Access Fitting open. Gage carrier plug is shouldered against safety ring. Pressure is admitted past primary seal through by-pass holes into hollow plug interior. Secondary O-ring provides positive seal.

COSASCO®
DIVISION
PERFECT CIRCLE CORPORATION

11655 McBEAN DRIVE, EL MONTE, CALIFORNIA
Export Office: 3631 Atlantic Blvd., Long Beach 7, California



Now...with

COSASCO®

ACCESS FITTINGS...

COMPLETE CORROSION SURVEYS

without system shutdown!

THE COSASCO ACCESS FITTING provides the key to successful corrosion survey work in transmission, storage, recovery and processing equipment. Previously, it had been difficult and costly—if not impossible—to run corrosion surveys inside pipelines and other pressure vessels without shutting down the system. Now, with Cosasco Access Fittings, corrosion surveys of all kinds can be made *under full operating pressures.*

CORROSION COUPON SURVEY. Enables the Corrosion Engineer to determine if corrosion is taking place. Grade 303 stainless steel coupon holder is installed through regular Cosasco Access Fitting body . . . can be easily inserted or withdrawn under pressure at any time. Holders are made in 3 categories adaptable to various line sizes and survey techniques. Corrosion coupons—available in standard lengths of 3″, 6″, and 8″, in any type of steel or rare metal—may be fully insulated from holders . . . remain unaffected by external soil conditions.

WATER SAMPLING SURVEY. Takes sample of line fluid for analysis. Special Cosasco water sampling plug with extension nipple and fluid catch attachment of S. S. 303 is inserted in Access Fitting body through main valve. An upper S. S. assembly consisting of a horizontal and vertical run, each with ½″ valve, is installed on the main valve. This permits taking a sample under full pressure and normal operating conditions to determine causes of corrosion.

THERMOCOUPLE SURVEY. Tells operator what part temperature is playing in corrosion problem. Cosasco thermocouple plug attachment (S. S. 303) is inserted in Access Fitting body and main valve is removed. Iron constantin wire is then pushed through gage carrier plug into position in the line. Thermocouple can be removed at will or hooked up to chart recorder for continuing temperature check.

ATOMIC HYDROGEN SURVEY. Discloses whether free atomic hydrogen is causing internal blistering. Cosasco hydrogen probe is installed through body of Access Fitting . . . can be easily withdrawn while vessel or line is on stream. Ball-check safety device protects against blowout or damage to gage should lower end of probe be damaged by excessive hydrogen in line fluid. Probe detects presence of free atomic hydrogen . . . gages rate of hydrogen diffusion.

RATE-OF-CORROSION SURVEY. Gives rate-of-corrosion reading electronically. Cosasco Corrosometer* Probe is installed under pressure through Access Fitting . . . quickly gives corrosion reading in increments of microinches without removing specimens or interfering with operations. Readings can be made in as little as 30 seconds without withdrawing the probe.

*T. M. Registered

FREE CORROSION SURVEY SERVICE

If you have a corrosion survey problem, Cosasco can help you solve it. Send details and blueprints and the Cosasco solution will be worked out promptly—at no cost to you.

FREE CATALOG. Send for new 32-page Catalog covering Cosasco's complete line of Access Fittings for Corrosion Surveys, Oilfield Production, Wellheads, Fracturing and Drilling.

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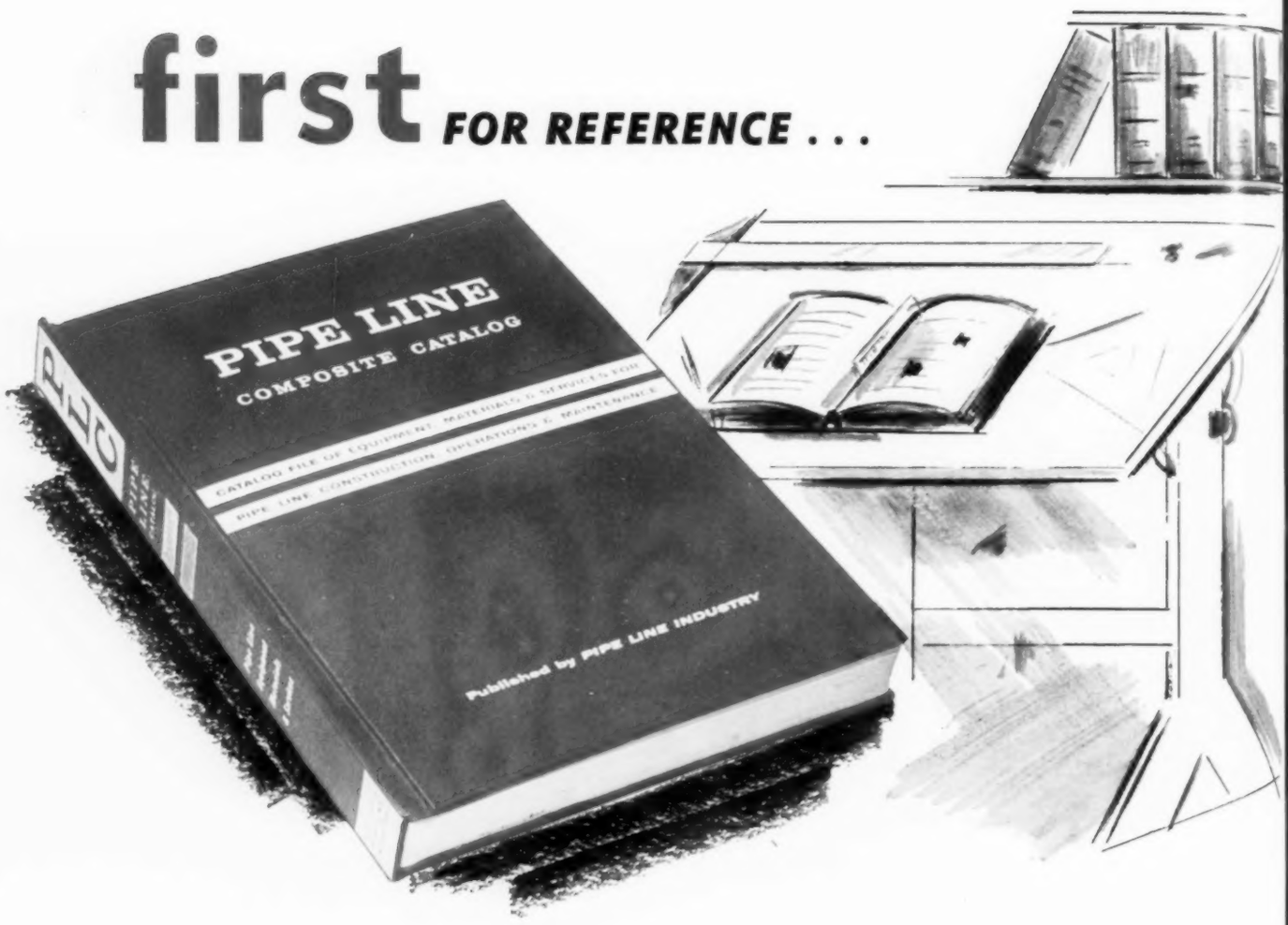

A *one-volume reference library* for purchasing and specifying. That's the best way to describe the only comprehensive catalog data file published specially for the Pipe Line Industry. Convenient to handle, thoroughly indexed, it is saving time and money for thousands of pipe line men.

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When you are ready to buy or specify, or if you just want planning information, look first in PIPE LINE COMPOSITE CATALOG.

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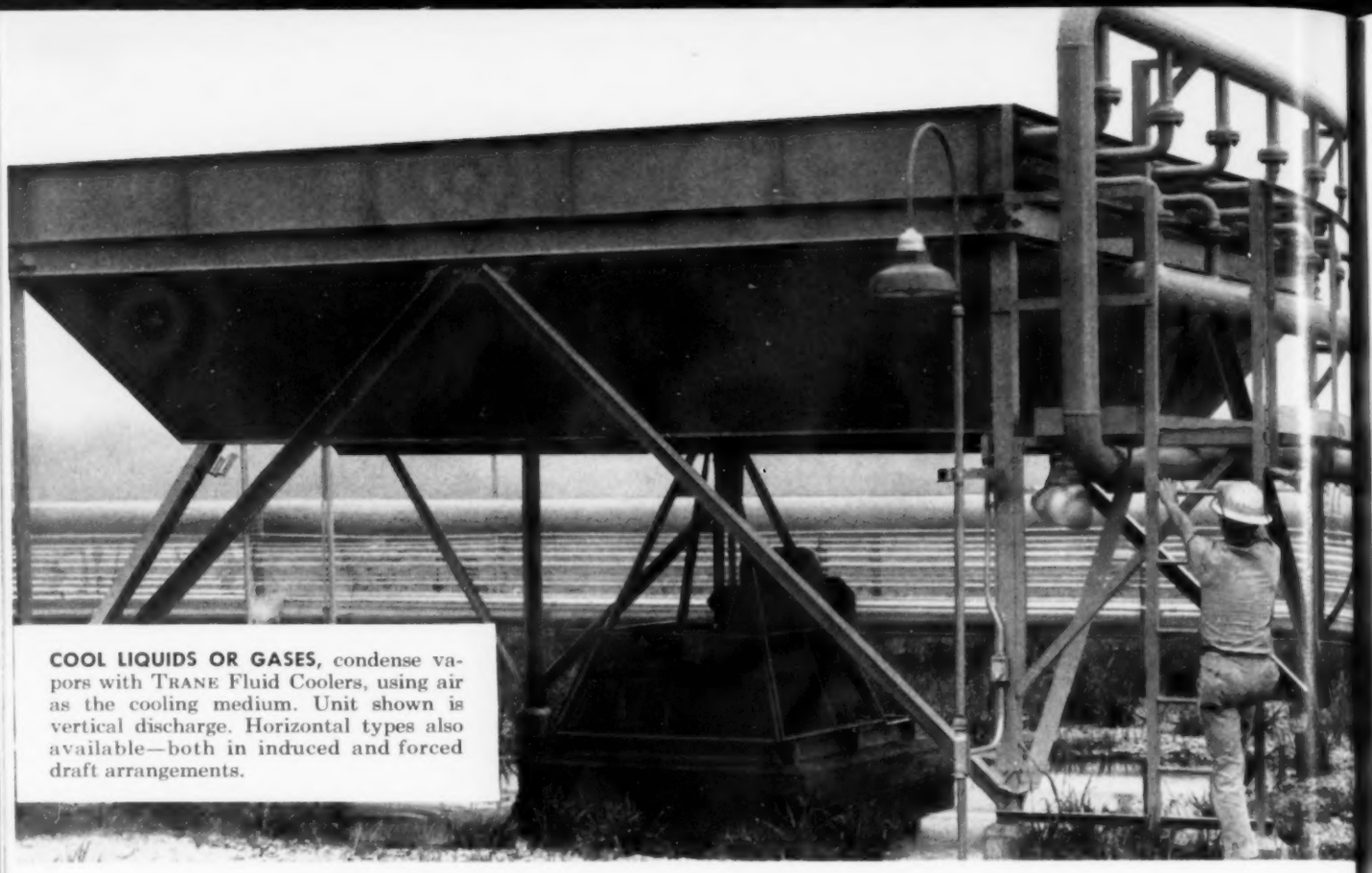


COOL LIQUIDS OR GASES, condense vapors with TRANE Fluid Coolers, using air as the cooling medium. Unit shown is vertical discharge. Horizontal types also available—both in induced and forced draft arrangements.

Lower erection costs, operating costs ...with versatile Trane Fluid Coolers!

Air-cooling now solving water supply problems for many refineries, petrochemical and natural gasoline plants

More and more engineers and plant designers are finding that *air-cooled heat exchangers* eliminate water supply and maintenance problems encountered with conventional cooling towers. These engineers report a substantial net reduction in over-all cooling costs and water consumption. Here are some of the ways TRANE Fluid Coolers are helping to solve heat transfer problems in many refineries and plants:

- **Low first cost.** Erection is simpler; fan, motor and gearbox are factory-aligned on a single metal base. Framework parts are pre-drilled, match-marked. Compact, simple, TRANE Coolers can often be installed on roofs, cutting real estate costs.
- **Lower operating costs.** Equipment needs only periodic cleaning of fin-tube surface. No need for special crews, maintenance facilities or spare parts. And TRANE Fluid Coolers have a life expectancy of 15-20 years—compared with 7-10 years for cooling towers.
- **Superior performance.** TRANE Coolers available with Admiralty stainless and carbon steel tubing to meet the most exacting specifications. Units are now in use in Canada and Bermuda—meeting extreme weather conditions. They also solve the problem of corrosion caused by salt-air atmosphere.

WANT MORE FACTS?

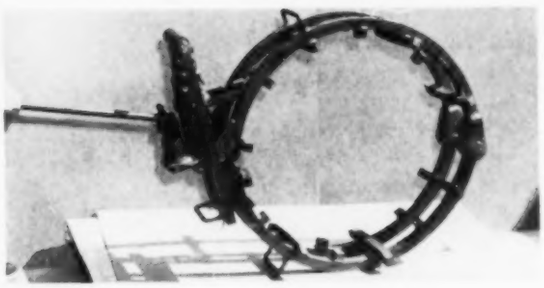
New Catalog S-395 has complete specification and application data on TRANE Fluid Coolers. For your copy, write TRANE, La Crosse, Wisconsin. Or just call your nearby TRANE Sales Office.

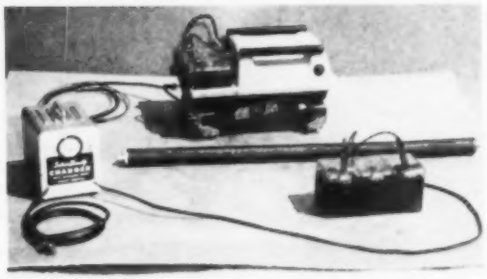
For any air condition, turn to

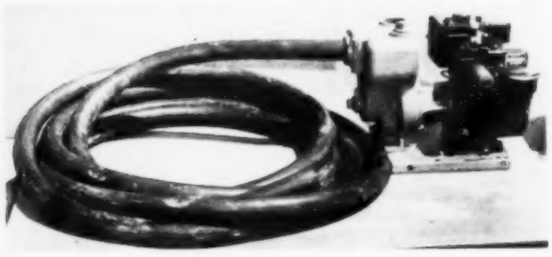
TRANE

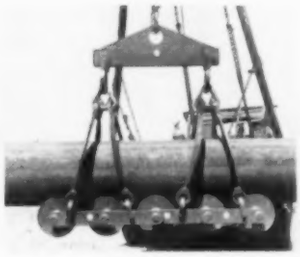
MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

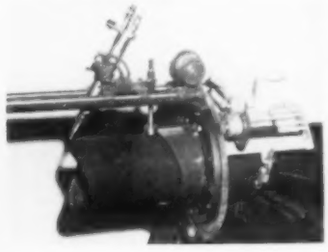
THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. • CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 97 U. S. AND 19 CANADIAN OFFICES

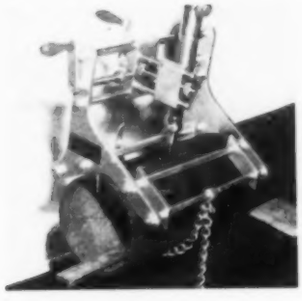


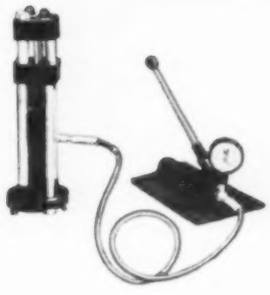












WHY BUY WHEN YOU CAN RENT FROM MYOCO

Have the equipment you need when you need it by renting from MYOCO. And, MYOCO can furnish equipment in any quantity as you need it.

Save capital investment and reduce equipment storage problems by renting from MYOCO.

MYOCO servicemen are experienced and available twenty-four hours per day—with fast transportation to serve you in any way. Efficient equipment operation is assured by periodical checks; parts and supplies shipped same day ordered, when possible.

We rent everything for the pipe line.

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- INTERNAL LINE-UP CLAMPS
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- HOLIDAY DETECTORS
- PIPE CRADLES
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MORRIS-YOUNG-OWENS CO.
PIPELINE EQUIPMENT AND SUPPLIES
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MORRIS-YOUNG-OWENS CO. PIPELINE EQUIPMENT AND SUPPLIES MYOCO

For quick delivery of MULTI-PURPOSE GREASE H, call your nearest Humble wholesale plant in Texas and New Mexico, or call or write:

Humble Oil & Refining Company
Consumer Sales
P. O. Box 2180
Houston 1, Texas

HUMBLE

MULTI-PURPOSE GREASE H
offers you these advantages:

- It allows you to buy one grease in quantity, and save on quantity discounts.
- It simplifies your record keeping and inventory.
- It keeps your storage requirements to a minimum.

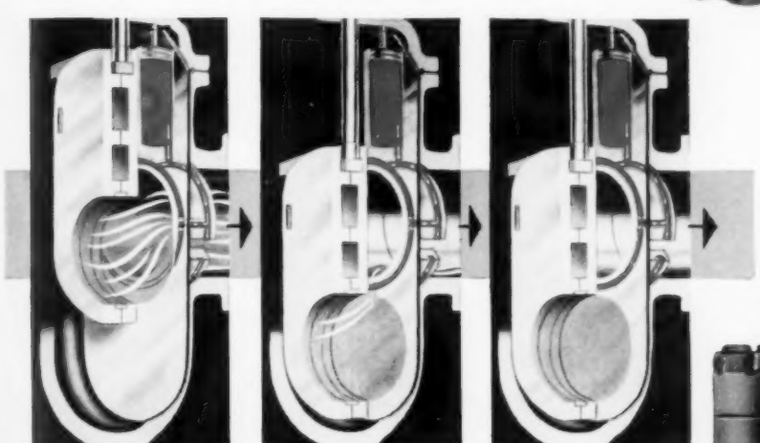
Using MULTI-PURPOSE GREASE H reduces the chance of applying the wrong grease. It gives faster turnover of opened cans, with less possibility of deterioration or contamination of the grease in opened cans.

Humble MULTI-PURPOSE GREASE H is a superior lubricant for chassis, track rollers, wheel bearings, water pumps, ball and roller bearings and universal joints. MULTI-PURPOSE GREASE H matches or exceeds the quality of every single-purpose grease it replaces. It's not affected by heat or water. And it maintains its consistency. This means it is easily applied even on cold days, and it gives sure lubrication summer or winter.

HUMBLE OIL & REFINING COMPANY

For pipeliners who hate leaks!

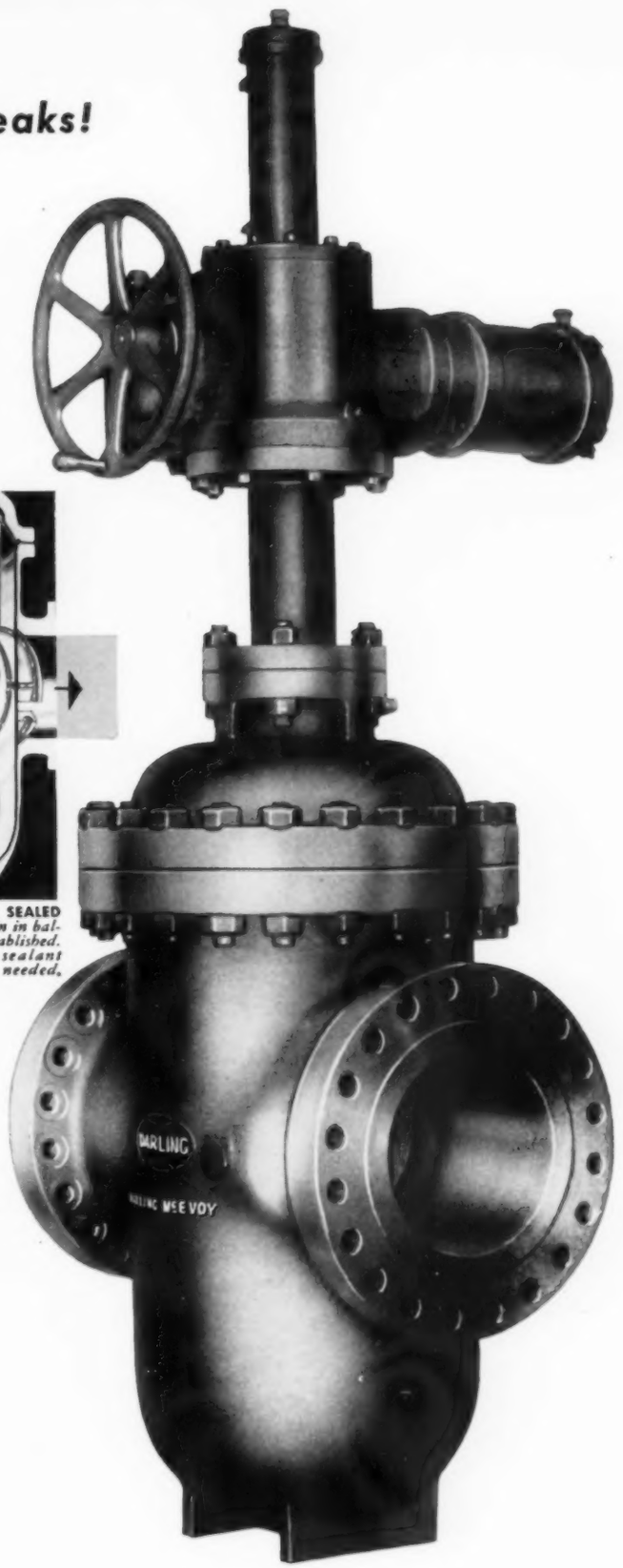
DARLING-McEVOY SELF-SEALING CONDUIT VALVES



APPROACHING CLOSURE ... *No loss of sealant as sealing groove in seat is disconnected from reservoir until gate is fully closed.*

CLOSED ... *Jumper in gate now permits differential pressure to feed sealant into seat groove to check any remaining flow.*

AUTOMATICALLY SEALED ... *Pressures again in balance. Tightness established. No additional sealant used until again needed.*



THE DIAGRAMS above show how these unique conduit gate valves seal themselves *automatically* . . . by means of a long lasting reservoir-held sealing compound . . . for leak-proof, pressure-tight closure every time! This feature, with flow in either direction, self-aligning non-wedging gates, and fully protected non-distorting seats, means exceptional performance, utility and service life. For additional information on these fully field-proved Darling-McEvoy valves, ask for Bulletin 5402.

DARLING VALVE & MANUFACTURING CO.

Williamsport 27, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Company, Ltd., Galt 19, Ontario

For more data on advertised products, use Readers' Service Cards, last page.

Near the line's western terminus, at an altitude of 2700 ft, crews are shown actually laying pipe down into a cloud bank.

There was rough terrain along the entire route of the Leidy Line. Grades of 40 pct and more were frequently encountered.

Contractor for Spread A, 65.53 mi, was Sharman, Allen, Gay & Taylor, Inc.; contractor for Spreads B (45.98 mi) and C (52.33 mi) was Panama-Williams Corp.

Working above the clouds on Transco's high-test line

There's some mighty rugged country in Pennsylvania, none of it tougher for pipe laying than along the route of Transco's Leidy Line. There, in the northern and eastern sections of the state, the Appalachian Mountains thrust their sharp ridges high above the valleys. For crews laying 24-in. Bethlehem line pipe, this meant working on severe grades, frequently up to 40 pct, and at altitudes ranging from 900 to 2700 ft. There's hardly a level stretch on the entire 164-mile length of the line. In addition, there are numerous crossings of rivers, streams, highways, and railroad rights-of-way.

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All of the API pipe laid from the Delaware River to the storage field was supplied by Bethlehem from our Steelton, Pa., fabricated pipe shop.

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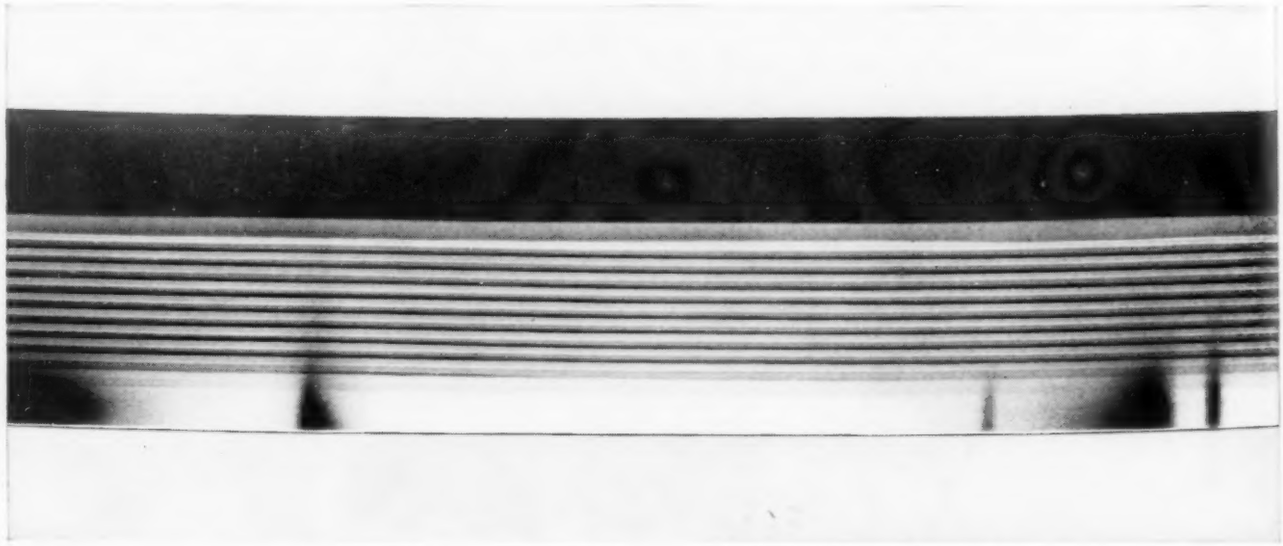

Bright highlight along lower face of ring shows area pre-seated by factory lapping.

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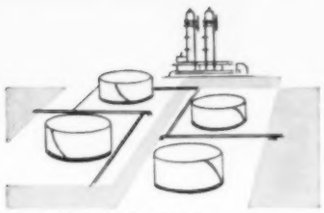
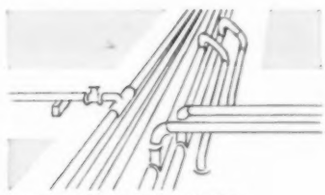


ON TANK FARMS



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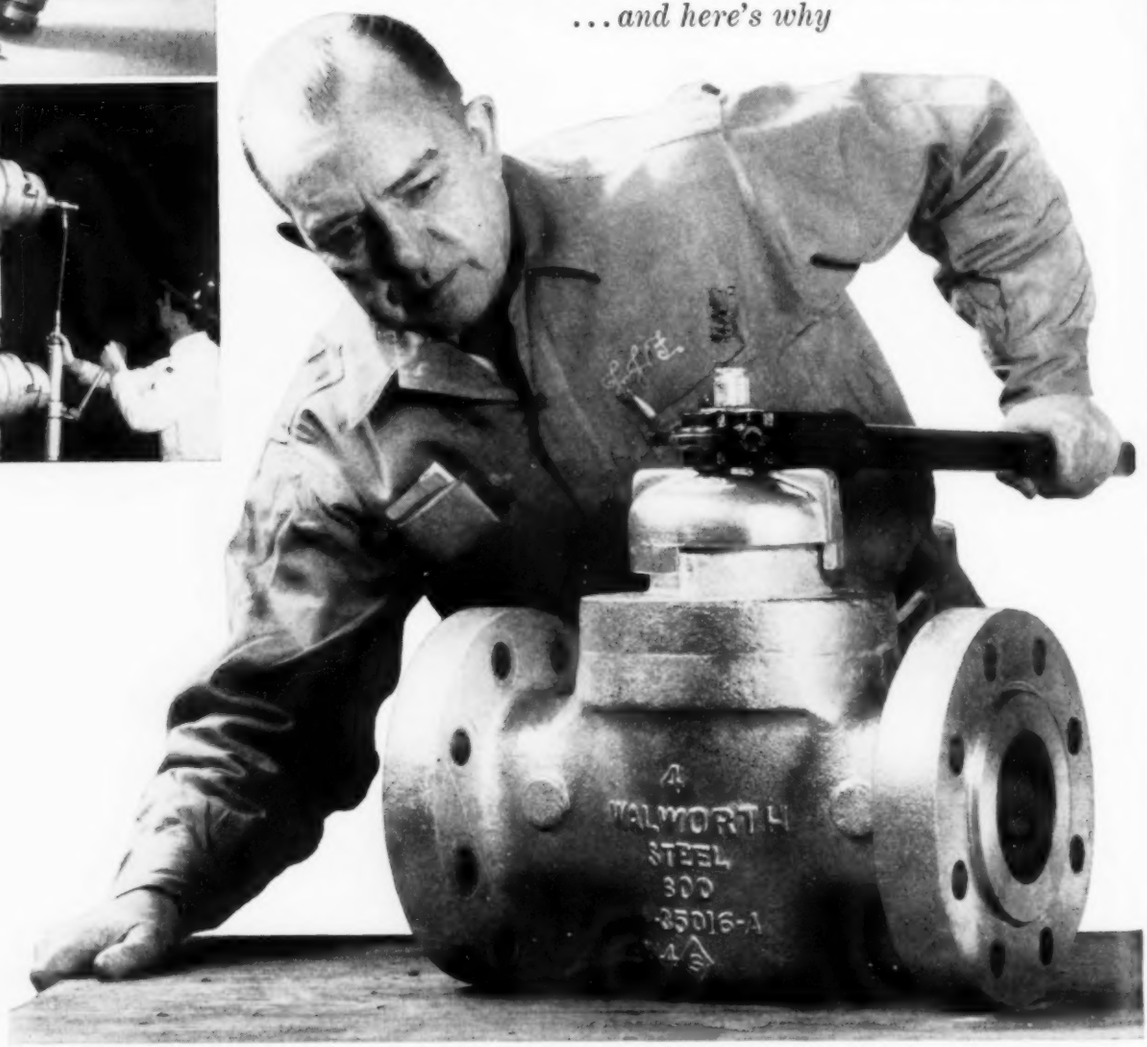

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PIPE LINE PANORAMA

Calcareous Coating Curbs Corrosion . . . Engineers have determined that when coating on offshore line is inadvertently damaged, it may be cheaper to overprotect and electro-coat line with calcareous deposit, then use regular cathodic protection. Practice saves high cost of relaying a section of the line having damaged coating. (See Page 36).

Surveys, based on 135-year-old theory, show that when electric current density of 50-400 milliamperes per square foot is impressed on an immersed steel structure, a calcareous scale will build up on bare sections. The most dense, thus most desirable calcareous coatings are formed at 100 to 200 milliamperes per square foot.

Word to the Wise Canadian (U.S.?) Contractor . . . Allis-Chalmers Vice President W. J. Klein recently told members attending Canadian Pipeline Contractors' annual meeting: "If every contractor will bid 5 percent higher in 1959, all of you will be around for this convention next year."

Supporting this comment, Klein said recent survey by one of the world's largest construction firms brought to light the surprising fact that had the company bid 5 percent higher on every job during past 10 years, there would have been 30 percent more net profit resulting from 30 percent less work.

Steel Strike Could Wreck a Record Year . . . Top pipe line spokesmen believe '59 may be biggest construction year in history—with one discouraging "if" to cloud the picture. The "if": With major wage and benefits battle brewing when steel union's three-year contract expires July 1, there is possibility of a prolonged steel strike. This could result in exhausted pipe stockpiles, slowing construction to a crawl—plus another hike in steel costs.

Federal Noose Tightens on Natural Gas Industry . . . If recent FPC decisions hold, no longer will transmission companies be able to move gas on "for hire" basis for distributors who have purchased gas directly from producers. No longer can large amounts of boiler fuel gas be shipped by interstate lines.

Result: Price structures in natural gas industry will be under more strict government control than ever. Competition in these areas will be severely curtailed. Incentive to meet fast-growing consumer demand for gas in non-gas states will be whittled down a few more notches. All this to satisfy the interests of local distributors who want to keep wellhead prices at rock bottom levels at a time when producer costs are soaring to new highs.

New Transportation Era for Natural Gas? . . . Successful arrival of double-hulled "Methane Pioneer" in England, carrying 32,000 barrels of Gulf Coast liquefied methane, may mark the beginning of a new transportation era for natural gas. Operating experience gained is expected to help determine design and construction of more and larger liquefied natural gas carriers.

What this means to the pipe line industry: If economics of shipping liquefied gas by tanker prove out, cheap hydrocarbon gases from Africa and Middle East might well be imported on U.S. East Coast. This combination of cheap gas and cheap transportation might eventually pose a threat to the U.S. transmission industry.

Calcareous Coatings—Corrosion Engineer's Offshore Ally

In salt water the protective current builds up a calcareous coating where current density is high. In some ways this "electrocoating" is superior to conventional coatings

By Donald M. Taylor
Taylor and Associates, Houston

ASK A CORROSION engineer who looks after offshore pipe lines to name his least difficult problem, and chances are, he'll say protecting pipe lines in sea water.

For this is one of nature's paradoxes. Sea water is a concoction of just about everything found on the earth, and it is super corrosive so far as steel is concerned. At the same time, it provides an almost perfect set-up for protecting the steel against corrosion. This anamoly was pointed up in a recent survey made among offshore pipe line operators. Before cathodic protection became commonplace, failures on lines that crossed salt water were common. But not one company cited a failure that could be traced to corrosion where the line had been protected.

From the corrosion engineer's viewpoint, there is little problem involved in protecting a sea going pipe line today. For one thing, the electrical resistance of the water is uniformly low, and even the mud and sand encountered on buried lines is salt water saturated, varying but little from the characteristics of the water itself.

But more important from the corrosion engineer's standpoint, is the tendency of sea water and current to heal imperfections in the coating of protected pipe lines. Sufficient current will "electroplate" certain minerals found in sea water onto bare steel, forming a hard, white calcareous coating which in some ways may be superior to other coatings. This tight-fitting scale will repair holidays in the coating and lower current requirements of the protection system. It will form under rust and barnacles—and may actually peel them from the surface of the steel if the current is sufficiently intense. In addition, calcareous coating will continue to provide protection for the line for some months after the maintenance current has been discontinued.[1]

The most exciting application of the coating to offshore difficulties came when engineers used a high density current to repair a severely damaged coating on an offshore pipe line which otherwise would have required re-laying. The savings ran into the hundreds of thousands. More about this later.

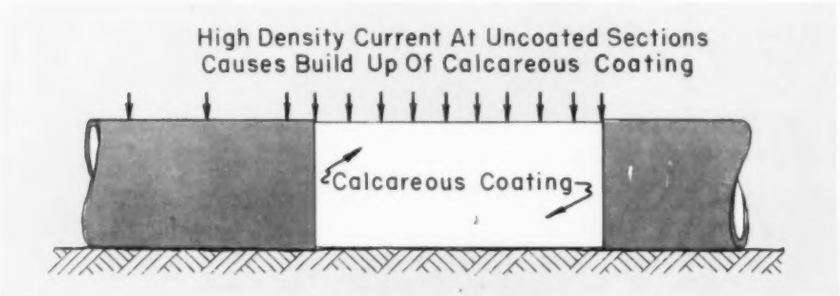
History of Calcareous Coating. Credit for the discovery of this coating goes to Sir Humphry Davy[2] who noted in 1824 that calcareous deposits were formed on the cathodes of galvanic couples immersed in sea water. Later in 1936, Col. G. C. Cox initiated an investigation into the characteristics of such deposits and patented[3] the use of high current density polarization treatments for electrocoating steel structures in sea water. This is generally known as the Cox marine electrocoating process. R. A. Humble performed additional experiments at Kure Beach, N. C., finding that the maintenance current required to protect steel surfaces could be reduced considerably for an over-all savings after the formation of a calcareous scale by an initial current in the order of 50 milliamperes per square foot.[4]

The leaders in practical application of this principle were E. P. Doremus and G. L. Doremus[1] who more-or-less established these procedures for protecting offshore structures.

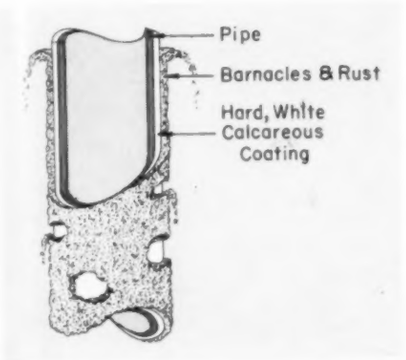
Composition of the Calcareous Deposit. When a current density on the order of 50 to 400 milliamperes per square foot is impressed on an immersed steel structure, a calcareous scale will build up on bare sections. The rate of deposition and the composition of the scale is primarily dependent on the density of the current.

From the standpoint of achieving supplemental protection for the structure, the best results are achieved between the range of 50 to 350 milli-

How current will "heal" imperfections in coating at sea on submarine pipe lines



How high density (50 to 400 MA/Sq. Ft.) current will exfoliate barnacles and rust



amperes per square foot. At 50 milliamperes per square foot, the coating will contain approximately 29 percent calcium, 6½ percent magnesium, 4 percent iron, 45 percent carbonate and 8 percent hydroxides. Sodium, silicon and chlorine will run slightly less than 1 percent each.[3]

At 400 milliamperes per square foot, the percentage of calcium drops to about 7 percent and magnesium increases to 29 percent. Iron reduces to 2 percent and the carbonate radical to 15 percent. The OH radical increases to 39 percent.

The most dense, and consequently most desirable calcareous coatings are formed at 100 to 200 milliamperes per square foot.[1] These coatings contain approximately equal parts of calcium carbonate and magnesium hydroxide.

One of the most noteworthy advantages of a calcareous coating is its ability to stand up despite an interruption in maintenance current. Coating dissolution is a slow process and so long as it remains on the steel it will maintain a high pH next to the metal surface. In addition, it helps exclude oxygen affording some resistance to cell activity. Even after considerable time with no maintenance current, protective voltages are easily re-established with original protective current densities which are usually in the range of 2.5 to 3.0 milliamperes per square foot.[1]

Electrocoating Offshore Structures. To build up sufficient deposit on bare steel, a total current of 6 to 10 ampere hours per square foot should be applied. Where a density of 50 milliamperes per square foot is used, the total elapsed time required to build up an adequate calcareous scale will be in the range of 200 hours—or eight days.

The source of this high density current can largely be determined by economics. Perhaps the most frequently used source used in the Cox process is a magnesium ribbon sized to produce about 100 ampere hours per lineal foot. This cored ribbon, which measures ⅜ x ¾ inches, can be cut to desirable lengths—depending on the total current required—and attached to the structure at spaced intervals. It will deliver 500 milliamperes per lineal foot against an unpolarized structure in sea water.

Thus if this magnesium ribbon is to be used to polarize and electrocoat a section of line, the first task will be to determine the amount of bare steel in the structure. For preliminary design purposes all steel in the mud and sand is assumed to have the same requirements as steel in sea water.

Example: Suppose a small platform in the Gulf has 10,000 square feet of bare steel which must be protected. If each square foot is to receive a total current of 10 ampere hours, (and each foot of magnesium ribbon supplies 100 ampere hours) a total of 1,000 feet of ribbon will have to be attached to the structure. Delivering 500 milliamperes per lineal foot, the ribbon will last 200 hours or eight days.

Of course, this process will be supplemented by the installation of maintenance electrodes—usually sized to provide 3 to 3.5 milliamperes per square foot for the life of the structure.

Repairing Damaged Coating at Sea. Laying pipe lines in the rough waters of the Gulf of Mexico can be difficult, and often coating may be damaged considerably before the line is completed. Some years back, the coating on a 12-mile line laid between two platforms was severely damaged by a jet trenching machine. The extent of the damage was such that the coating would have to be repaired or the line would have to be re-layed.

However, the contractor and owner company decided to try the electrocoating method on the line and engaged a consulting firm to execute the plan.

The consultant's first step was to determine the extent of the damage in terms of square feet of bare steel. He was able to accomplish this simply and inexpensively. Setting a DC generator on one platform and hooking it onto the line, he proceeded to take readings at the other platform, recording the potential shifts as the input current was varied.

With a workable assumption as to the square footage of bare steel involved, he calculated the amount of magnesium line anode that would be required to produce the high density current to electrocoat the line. At the same time, he determined the size of maintenance anodes which would be required to protect the line.

The next step was to clamp both sets of anodes to the line at half-mile intervals. In addition, he decided to make one operation do for three, and clamped the test leads, buoys etc. to the line at the same time.

The line was then located at half-mile intervals—this was somewhat difficult because the tides had partially backfilled the ditch—and after the diver removed all vestiges of coating from a three-foot area, he attached an ordinary leak clamp. To this clamp the two anodes, test leads and buoy was attached. This operation was repeated at half-mile intervals for the length of the line.

Once the high density current source had been dissipated, a profile of the line was run using the test leads and a reference electrode. This profile revealed that the entire line was under adequate protection and the current requirements were normal as expected.

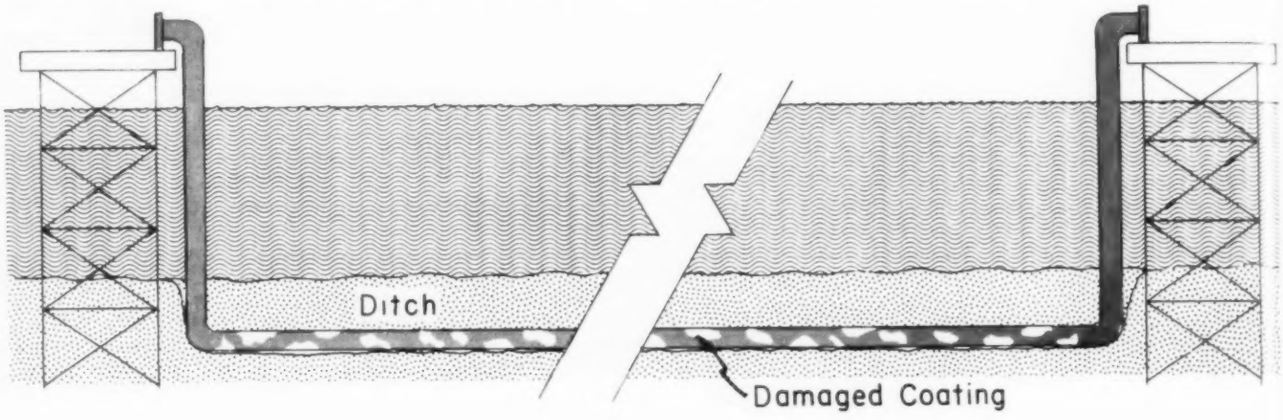
The savings on this job ran into several hundred thousand dollars.

What About Exfoliation? One of the most frequently asked questions about this process has to do with the exfoliation of rust and barnacles described above. If the high density current will actually wedge them from the steel, why won't it do the same for the coating on the structure?

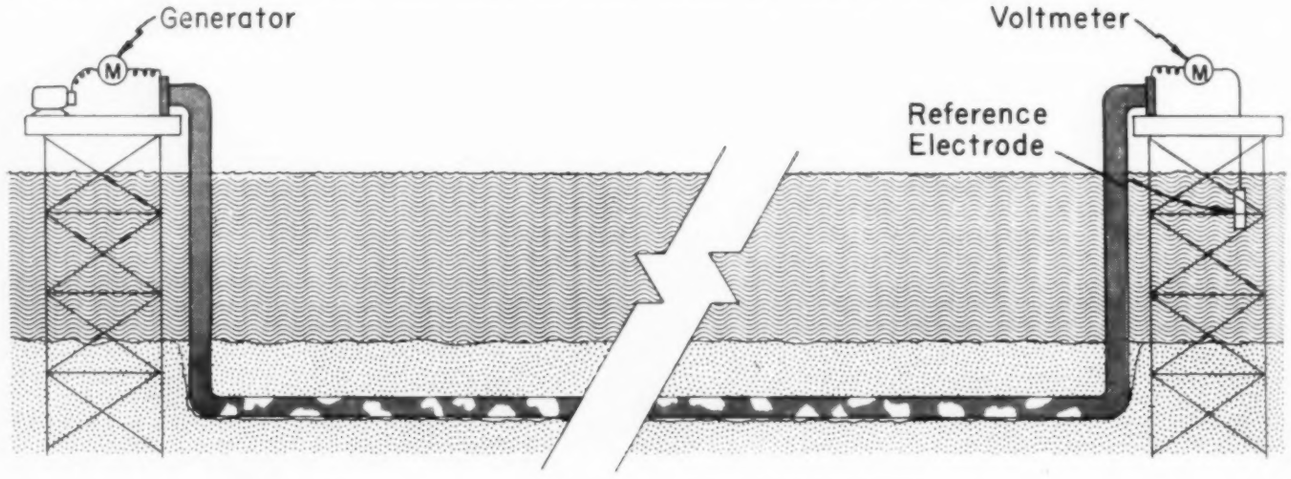
The answer, is that the depoistion of calcareous deposit is a function of current density on the metal surface; where the steel is bare, the current density is highest, and the consequent deposition is greatest. Without doubt, current of extreme density would damage the coating.

Applying the Technique to Uncoated Platforms. The technique of using high density current to polarize and coat bare steel platforms in the Gulf of Mexico and on the eastern seaboard has been used successfully. Sufficient years have elapsed to properly evaluate the results, and in every instance, these results have proved

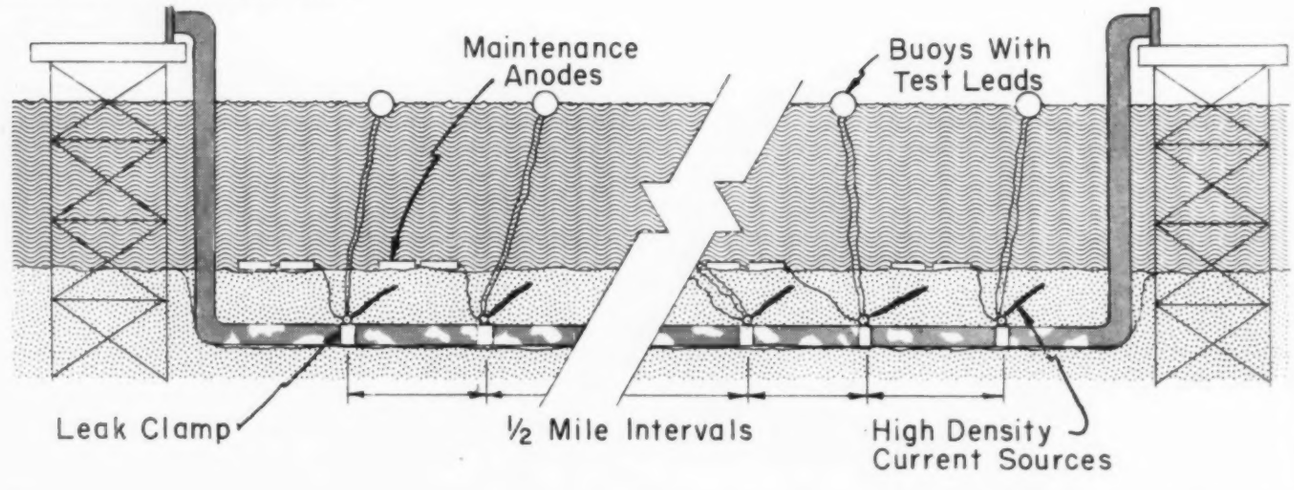
PROBLEM: Coating on 12-mile offshore line severely damaged—re-lay the line?



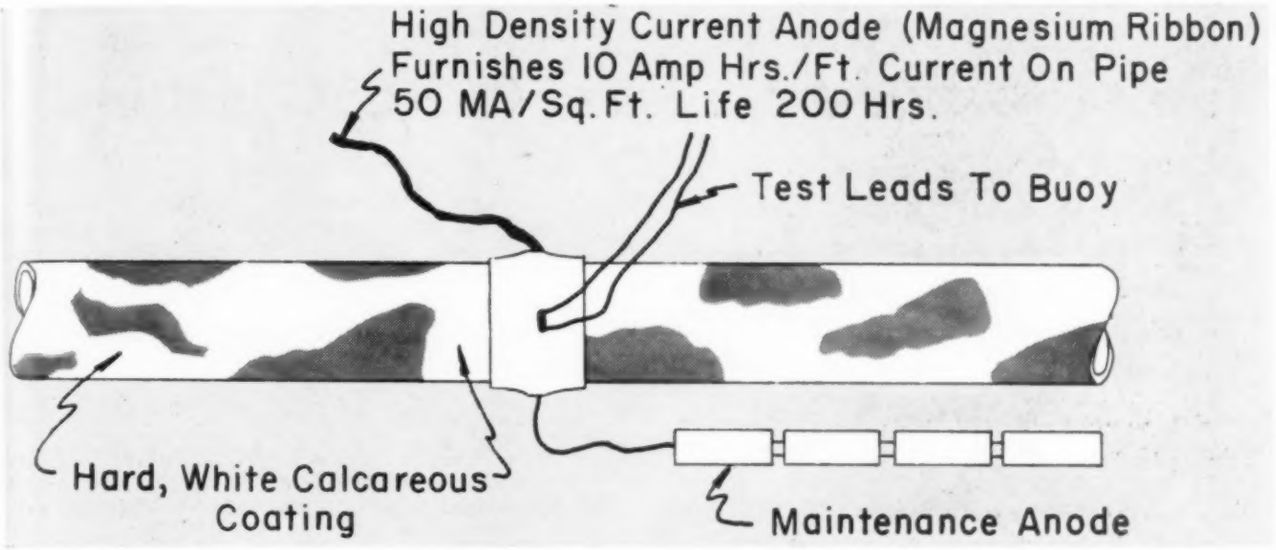
SOLUTION, Step 1: Find the area of bare steel by study of potential shift



SOLUTION, Step 2: Install source of high density current anodes plus maintenance anodes every half mile



SOLUTION, Step 3: High density anode is consumed, forming calcareous deposit on uncoated pipe. Make survey for continuing protection


High Density Current Anode (Magnesium Ribbon)
Furnishes 10 Amp Hrs./Ft. Current On Pipe
50 MA/Sq. Ft. Life 200 Hrs.
Test Leads To Buoy
Hard, White Calcareous Coating
Maintenance Anode

satisfactory.

One pipe line company used the technique to reduce the cost of protecting a meter platform in New York harbor. The process described above was employed—using magnesium ribbons to supply the short lived, high density current and regular high purity magnesium anodes to provide maintenance current for subsequent protection. After about six years, the success of the initial polarization and calcareous coating can be little doubted. Company engineers estimate that the savings in current requirements for the first year ran something like 40 percent. The savings over the long haul are even more startling.

Conclusions. There are still question marks in this field. The splash zone area in particular is not easily solved —even with the very best of coatings. However, it should be pointed out that no widespread research project along these lines has been carried out. As more companies expand seaward for new oil and gas reserves, it becomes more obvious that the limitations and advantages of calcareous coatings should get a second long look. For example, what would be the effect of imposing a high density current on platforms and risers at periods of high tides? Would the calcareous deposits thus formed prove adequate in the splash zone? One pipe line operator has had considerable success along these lines. The splash zone was wrapped with burlap which served as a wick, staying wet and transmitting protective current to the steel.

Another poser among the questions which might be asked regarding use of calcareous deposits to protect offshore structures has to do with coating breakdown. How much is too much current? In other words, could too much current break down and repair coatings without the knowledge of the engineer, etc.?

Also, what is the effect of variance in salinity of the water during the time the calcareous coating is being plated on the pipe? There have been instances where bay crossings seemingly gave considerable resistance to polarization even with high density currents.

The answers to these and many other questions will likely be forthcoming in a few years. Meanwhile, offshore protection techniques have progressed to the point that line failures are hardly contemplated if the line's protection system is properly engineered. Part of the credit should be given to the sea itself and its "healing" calcareous scale.

About the Author

Donald M. Taylor, former editor of PIPE LINE INDUSTRY has "retired" from active editorial work. "For the simple reason that as an editor I found little time for writing," explains Don. Aside from writing technical articles, doing consulting and serving as a director of a chemical company, Taylor is devoting his efforts to the oil industry—as an oil producer. He is a graduate of Hardin-Simmons University. In the graduate school at Stanford University Taylor studied engineering, journalism, business and other courses.

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PART 1

How to Design Impressed Current Systems

Basically it is a simple problem—but it grows more and more complex as the engineer seeks the most economical combination of units

By James C. Bell, Engineer
Service Pipe Line Company, Tulsa

THE THREE THINGS that a corrosion engineer is trying to determine in designing an impressed current protection system are the size, number, and location of rectifier-ground bed units. It is possible to protect a given pipe line with one unit (if it is large enough) located at some point near the middle of the line. It follows, too, that we could accomplish protection with 10, 20, or a 100 units of progressively smaller current capacity per unit installed at intervals along the line. We need to find out which combination is the most economical; field surveys and power cost factors must be considered, too.

One Unit or Ten? First, let's consider the power requirements for two hypothetical methods of supplying an impressed current of 100 amperes to a pipe line. If we drain this current to one rectifier unit operating at a conversion efficiency of 50 percent against a circuit resistance of 0.5 ohm, the AC power consumption will be

$$P_{AC} = (I^2R)_{DC}\,(100\%/50\%)$$
$$= 100^2 \times 0.5 \times 2$$
$$= 10{,}000 \text{ watts}$$

Now, if we supply the 100 amps by draining 10 amps to ten units distributed along the line, each working at 50 percent efficiency against a 0.5 ohm circuit, the AC power consumption per unit will be

$$P_{AC} = 10^2 \times 0.5 \times 2$$
$$= 100 \text{ watts or } 1{,}000 \text{ watts total}$$

Look at Power Costs. The monthly power bill for the first method, assuming an average charge of $0.02/kwh, would be $146: that for the second method, assuming an average charge of $0.06 kwh, would be $43.80. The difference in power cost amounts to some $1,200 annually.

Although this comparison is somewhat extreme, due to the constant circuit resistance assumed, it serves to point out the potential savings in power costs offered by multiple, small-capacity units.

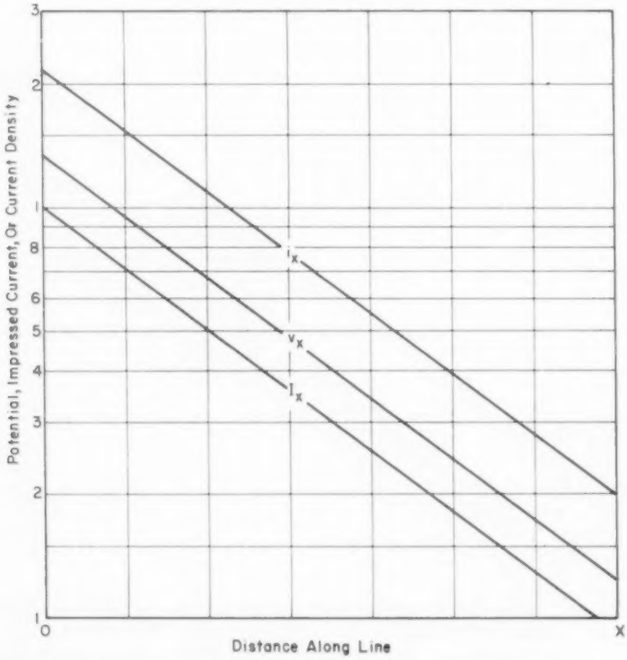


FIGURE 1—Plot of electrical attenuation along a section of pipe line shows exponential relationship of potential, impressed current, and current density to distance away from the point of current drainage.

More Units Cuts Total Current Needs. In the foregoing comparison we assumed a circuit resistance of 0.5 ohm in both cases. When possible to do so, we would probably find it more economical to design nearer to 0.2 ohm for a 100-amp unit and 1.0 ohm for a 10-amp unit. This would effect a considerable reduction in the difference between annual power costs of the two methods of supplying 100 amps, but we must go a step further.

The *total current* required to provide cathodic protection *decreases* as the *number* of units supplying that current *increases;* percentage decrease being dependent on the characteristics of the line. Where one unit has to supply 100 amps, ten units might do the job with a total of 40 amps; or six 10-amp units might be sufficient.

Consider Installation and Maintenance. We have seen how we can bring about a reduction in power costs by increasing the number of impressed current units supplying current to a given line. On the other hand, installation and annual maintenance costs usually grow as the number of units increases.

The "point of least annual cost" is the goal; that is the point where the power cost savings from installing an additional unit fails to offset the cost of that unit. (Although a discussion on economics is beyond our scope here, we should remark that an evaluation of this kind

requires consideration of the time value of money, tax structures, and depreciation allowances.)

Final design is influenced, of course, by many factors over which we have no control; but we should strive for the system showing the least annual cost.

Potential Surveys. To design an impressed current system, we must first know how various magnitudes of current, draining to one or several units, affect the line; usually with regard to changes in pipe potential. The surest way to obtain this knowledge is to make numerous test installations at various points along the line; then observe the results of impressing different magnitudes of current from each location. In many cases, such as most bare lines, no other method will serve.

Make Attenuation Work for You. Many lines lend themselves to a much less time-consuming and far simpler method of study. This method makes use of the so-called attenuation characteristics of pipe lines; it is applicable to many coated lines. Proper use of the attenuation equations can substantially reduce the amount of survey work necessary to the design of an impressed current system. A knowledge of attenuation theory will provide a better understanding of impressed current phenomena. If we install a DC source at some location along a pipe line, and impress sufficient current, the potential of the line can be shifted to a more negative value for some distance on either side of the drain-point. The potential change is greatest at the drain point (if the ground-bed is properly located) and decreases or attenuates with increasing distance from this point. As the impressed current is increased, the length of line shifted to a more negative value increases.

Attenuation equations, where applicable, permit use of limited data to predict the manner of attenuation and the effects of varying magnitudes of impressed current. The accuracy of prediction depends upon how nearly the theoretical conditions assumed in deriving the equations approach actual conditions. In general, 100 percent accuracy is neither practical nor required. Good engineering practice in any field of endeavor usually dictates the use of safety factors.

These attenuation equations for pipe lines were borrowed from electric power transmission line theory; it is shown that for a line delivering a steady current flow the electromotive force (V) and current strength (I) at any point "x" distance from the origin may be determined from the following equations:

$$V_x = V_o \cosh \alpha x - I_o R_k \sinh \alpha x \qquad (1)$$

$$I_x = I_o \cosh \alpha x - \frac{(V_o)}{R_k} \sinh \alpha_x \qquad (2)$$

The symbols "α" and "R_k" which will be discussed later, denote the attenuation constant and characteristic resistance of the section of line in question; subscripts "x" and "o" relate the variables to the distance x and the origin. These equations require that the line be perfectly uniform throughout the section. In pipe line usage, wherein current flows to the line from a ground-bed, the derivation requires the additional assumption that the ground-bed is remotely located from the line.

Having imposed two impossible conditions in deriving equations (1) and (2) we will now consider a third; and

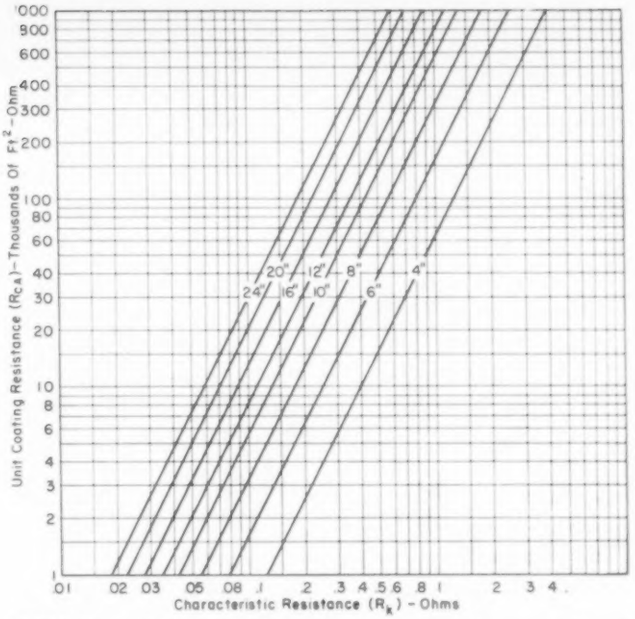


FIGURE 2—Characteristic resistance represents a portion of the circuit resistance opposing flow of the impressed currents. It determines the magnitude of potential at the drain point and at any remote point along the line. It varies with pipe size and unit coating resistance.

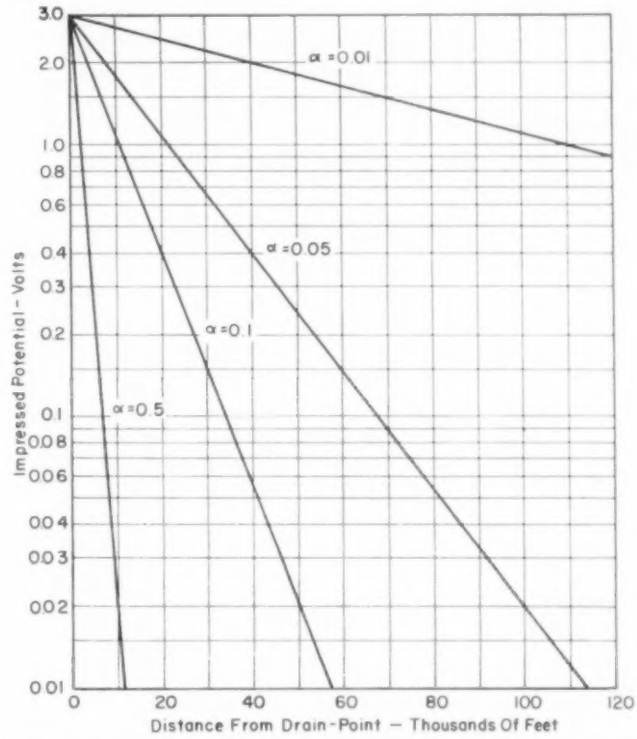


FIGURE 3—With the voltage at the drain point assumed to be constant the slope of the attenuation curve depends upon the attenuation constant. The higher the value of the constant, the quicker does voltage drop off as we move down the line to test points.

forget for the time being that these conditions never exist. If we assume the pipe line to be infinitely long it can be shown that

$$V_o = I_o R_k \qquad (3)$$

$$V_o/I_o = V_x/I_x \qquad (4)$$

These relationships, when applied in the fundamental

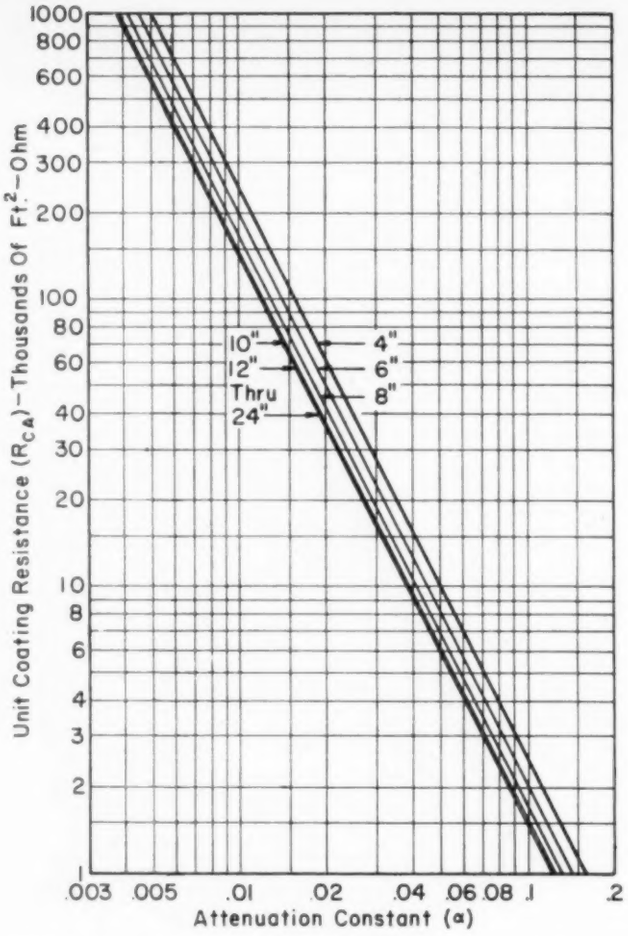


FIGURE 4—Magnitude of the attenuation constant is influenced by pipe size and unit coating resistance as shown here. For this reason it is also affected by coating quality.

equations (1) and (2) lead to the derivation of the following simple and very useful equations:

$$V_x = V_o e^{-\alpha x} \quad (5)$$

$$I_x = I_o e^{-\alpha x} \quad (6)$$

By a similar process, the relationship for current density is shown to be

$$i_x = i_o e^{-\alpha x} \quad (7)$$

The symbol "e" denotes the Napierian base, 2.718. Equations (5), (6), and (7) are the attenuation equations most often referred to in the literature. Their usefulness derives from the fact that a plot of the logarithm of V_x, I_x or i_x versus distance from the origin yields a straight line, as illustrated by Figure 1. (In strict accordance with electromagnetic field theory, equations (5), (6), and (7) are approximate solutions to complex equations and do not hold for large values of αx.[1] Thus, points far from the origin will gradually deviate from a straight line.)

What This Means in Pipe Line Terms. Now let's take a look at the variables represented by the symbols in the foregoing equations. We will define these variables in terms of pipe line usage.

"V" represents the potential impressed at a point on the line by current flow to that point; it is an IR drop potential. When we measure pipe potential with an impressed current flowing, we include a phenomenon which electromagnetic field theory does not take into account. When impressed current is applied, an instantaneous chemical change occurs in the environment surrounding the pipe line. This change, which may be called concentration polarization, introduces an electromotive force which exists as long as current flows.

In its initial stage, the effect of concentration polarization disappears rapidly when the impressed current is stopped. When impressed current is maintained over a long period of time, however, permanent changes occur. Effects of concentration polarization cannot be predicted readily, and may or may not be significant.

They must be included in the final analysis, but should be excluded insofar as possible from the values used in developing an attenuation curve. This can be done by measuring the instantaneous change in pipe potential when an impressed current is interrupted periodically. (A one minute cycle, 45 seconds on and 15 seconds off will usually suffice.) The impressed potential is then approximately equal to the difference in pipe potential thus noted, or

$$V = E_{on} - E_{off} = \Delta E \quad (8)$$

Polarization Potential. The difference, if any, between the "off" potential and the normal or static potential of the line as found is referred to by M. E. Parker as the polarization potential, V_p. Parker has proposed[2] that there is a functional relationship between impressed potential and polarization potential such that a plot of V_p versus V_x on logarithmic graph paper yields, with some explainable anomalies, a straight line. There is reason to believe that this relationship cannot hold indefinitely as V_x is made increasingly larger, but it seems to work in the low range of values we normally encounter.

Voltage Factors. "V_o" represents the impressed potential at the drain-point: its functional relationship for a line of infinite length is given by equation (3). "V_x" is the impressed potential caused by the leakage current "I_x" flowing to a point "x" distance from the drain-point. From (3) and (4) its functional relationship is

$$V_x = I_x R_k \quad (9)$$

Current Terms. I_o represents the total impressed current picked up by the line on one side of the drain-point. For the hypothetical conditions assumed and with the drain-point located in the middle of the line, the current flow to each side will be equal and the source current or drain current is related to I_o as

$$I_a = 2\,I_o \quad (10)$$

Resistance Definitions. The attenuation constant and the characteristic resistance are both functions of the longitudinal resistance of pipe, R_s, and the leakage resistance from pipe to ground, R_1, as follows:

$$\alpha = (R_s/R_1)^{1/2} \quad (11)$$

$$R_k = (R_s R_1)^{1/2} \quad (12)$$

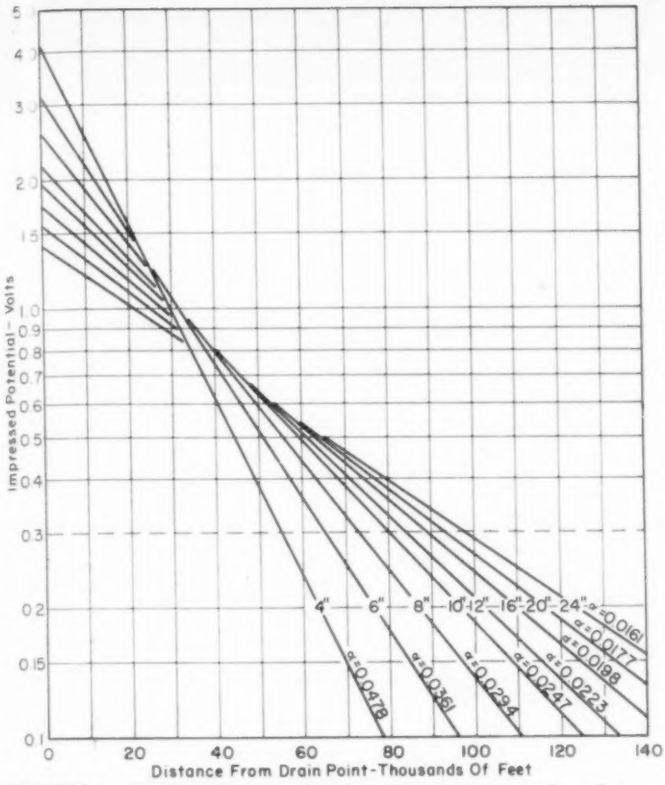


FIGURE 5—Family of curves showing distance from drain point to an impressed potential of 0.3 volt for various sizes of pipe. These curves are based on a 20 ampere current drainage and constant leakage resistance.

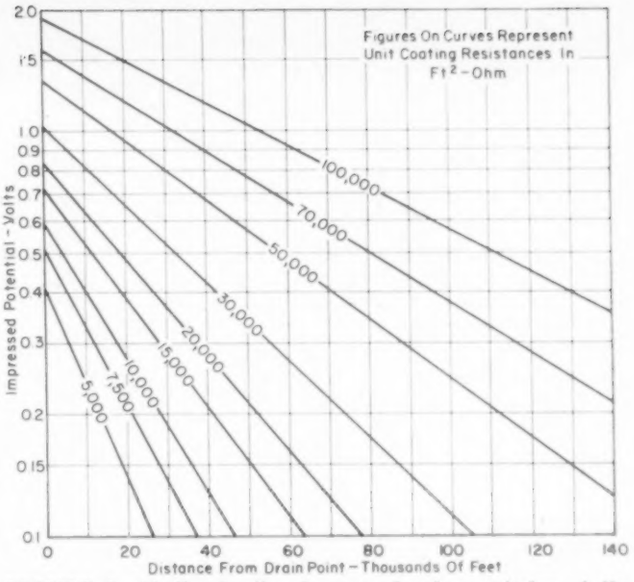


FIGURE 6—Similar family of curves showing variation of distance from drain point to an impressed potential of 0.3 volt for various qualities of coating, but assuming a constant longitudinal resistance. Again this set of curves is based on a 20 ampere current drain.

These quantities are usually computed on the basis of 1,000 ft., or one kilofoot, of pipe. Charactertistic resistance is important insofar as it represents a portion of the circuit resistance opposing the flow of impressed current and determines the magnitude of V_o and V_x for a given impressed current. This resistance may be defined as "that which is seen by current flowing to one side of a drain-point." The drain current "sees" two characteristic resistance electrically in parallel; or an effective resistance, R_g, equal to $R_k/2$. Substituting in (3) and (10) we get

$$R_g = V_o/I_a \qquad (13)$$

Figure 2 illustrates how R_k is affected by varying R_s (e.g. changing pipe size) and R_l (e.g. changing coating quality.) It is noteworthy that for a given drain current and quality of coating, V_o as determined from (3) or (13) varies with pipe size.

Slope of Attenuation Curves. Of particular interest in impressed current system design is the slope of the attenuation curves. As we deduce from equations (5), (6), and (7), the magnitude of the attenuation constant determines this slope, as illustrated in Figure 3.

Since the magnitude of α is governed by R_s and R_l, as illustrated by Figure 4, the slope of the attenuation curves is also a function of pipe size and coating quality. We can rearrange equations (3), (5), and (10) to obtain

$$V_x = (I_o R_k) e^{-\alpha x} \qquad (14)$$

and

$$V_x = \frac{(I_a R_k)}{2} e^{-\alpha x} \qquad (15)$$

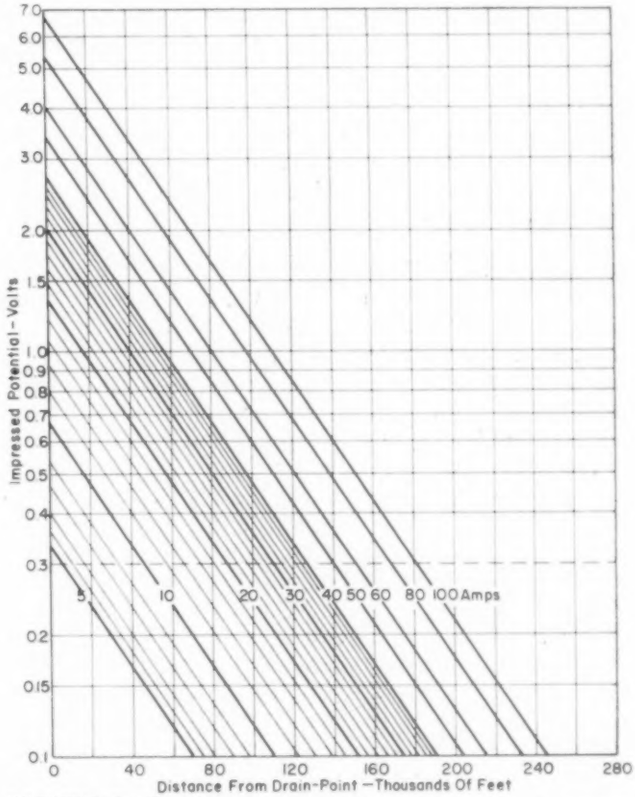


FIGURE 7—The impressed potential at any point is proportional to the impressed current. Once an attenuation curve is drawn for a given current value, curves for other values may be constructed.

Thus the variables which influence the magnitude of α also determine the magnitude of the impressed potential produced at a given point by a given drain current; or the point at which a given impressed potential is pro-

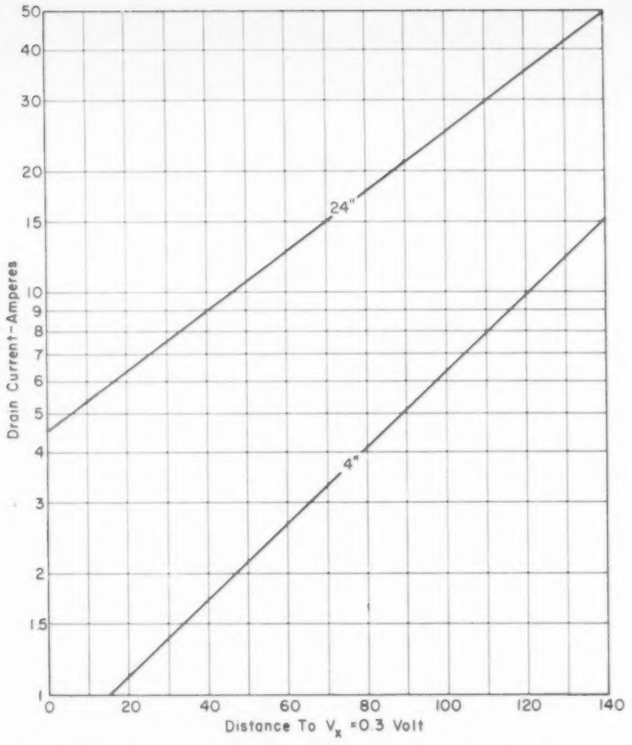


FIGURE 8—The plot of the logarithm of impressed current versus spread to some fixed impressed potential (in this case 0.3 volt) yields a straight line. Only three coordinate points are needed to construct a curve which covers the board.

duced by a given drain current. These effects are illustrated by Figures 5 and 6 where the attenuation curves for a 20-amp drain are developed for various pipe sizes (or unit coating resistances) with a constant leakage resistance (or longitudinal resistance).

Voltage-Current Relationships. Another fact is apparent from equations (14) and (15). The impressed potential at any point is directly proportional to the impressed current; if I_o doubles, so does V_x. Once the attenuation curve for a given current is known, curves for other currents can be constructed by proportion. This relationship is illustrated by Figure 7.

We can go a step further. Since the distance or spread to any given impressed potential increases as an exponential function of the impressed current, a plot of the logarithm of impressed current versus spread to some fixed impressed potential will yield a straight line as shown in Figure 8. So we need only three coordinate points to construct a curve which covers the board.

The exponential relationship of drain current to protective spread is worthy of additional attention. This relationship can be seen more clearly if the variables are plotted on regular coordinate paper, as illustrated by Figure 9. As drain current increases, the percent gain of protective spread diminishes; a point is reached where a substantial increase in drain current (and power cost) results in only a small increase in protective spread.

Multiple Unit Effects. Up to this point we have concerned ourselves with the effects of only one impressed current unit. As a rule, the line under consideration will require two or more units. This being the case, we need to consider multiple unit effects.

We have seen that the magnitude of impressed poten-

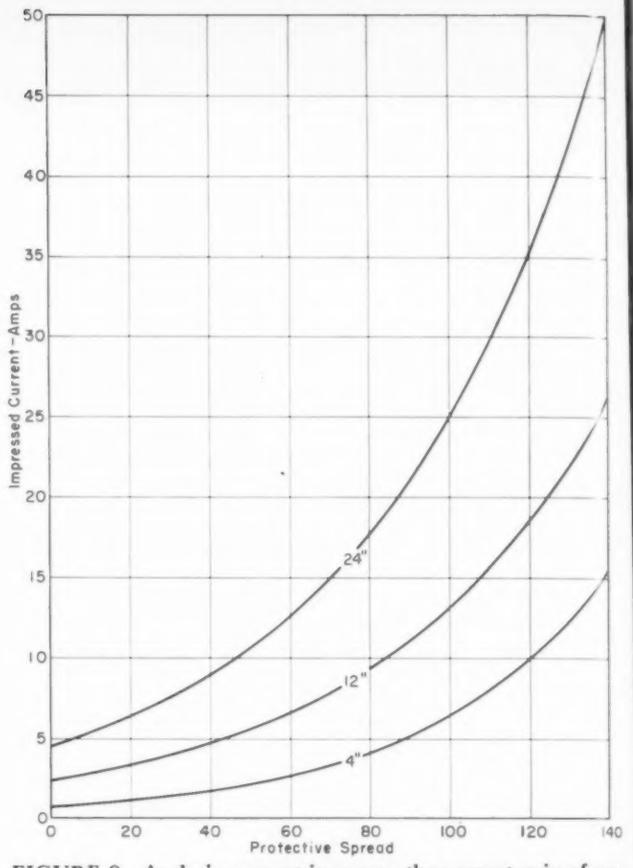


FIGURE 9—As drain current increases, the percent gain of protective line spread diminishes. At some point a substantial increase in drain current (and power costs) results in only a small increase in protective spread. This plot is "looking" in one direction from a drain point to a Δ E equal to 0.3 volt. Unit coating resistance is assumed to be 50,000 ft.²-ohm.

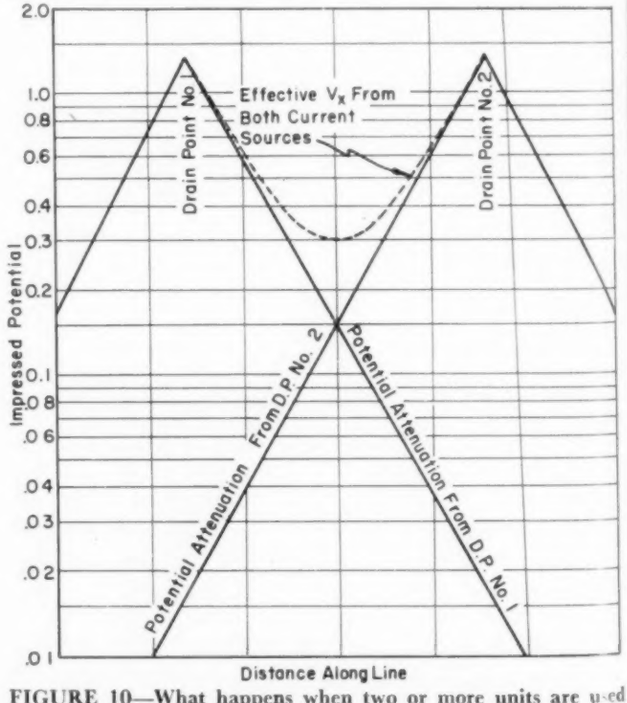

Impressed Potential
Distance Along Line
Drain Point No. 1
Drain Point No. 2
Effective V_x From Both Current Sources
Potential Attenuation From D.P. No. 2
Potential Attenuation From D.P. No. 1

FIGURE 10—What happens when two or more units are used to protect a section of line? At some point about midway between the two drain points equal quantities of current would be draining from each unit. As we move toward either unit from this point, leakage from the nearer unit increases; that received from the farther unit drops off with comparable effects on impressed potential at each point. Addition of a third unit beyond the second will lend to a total affect.

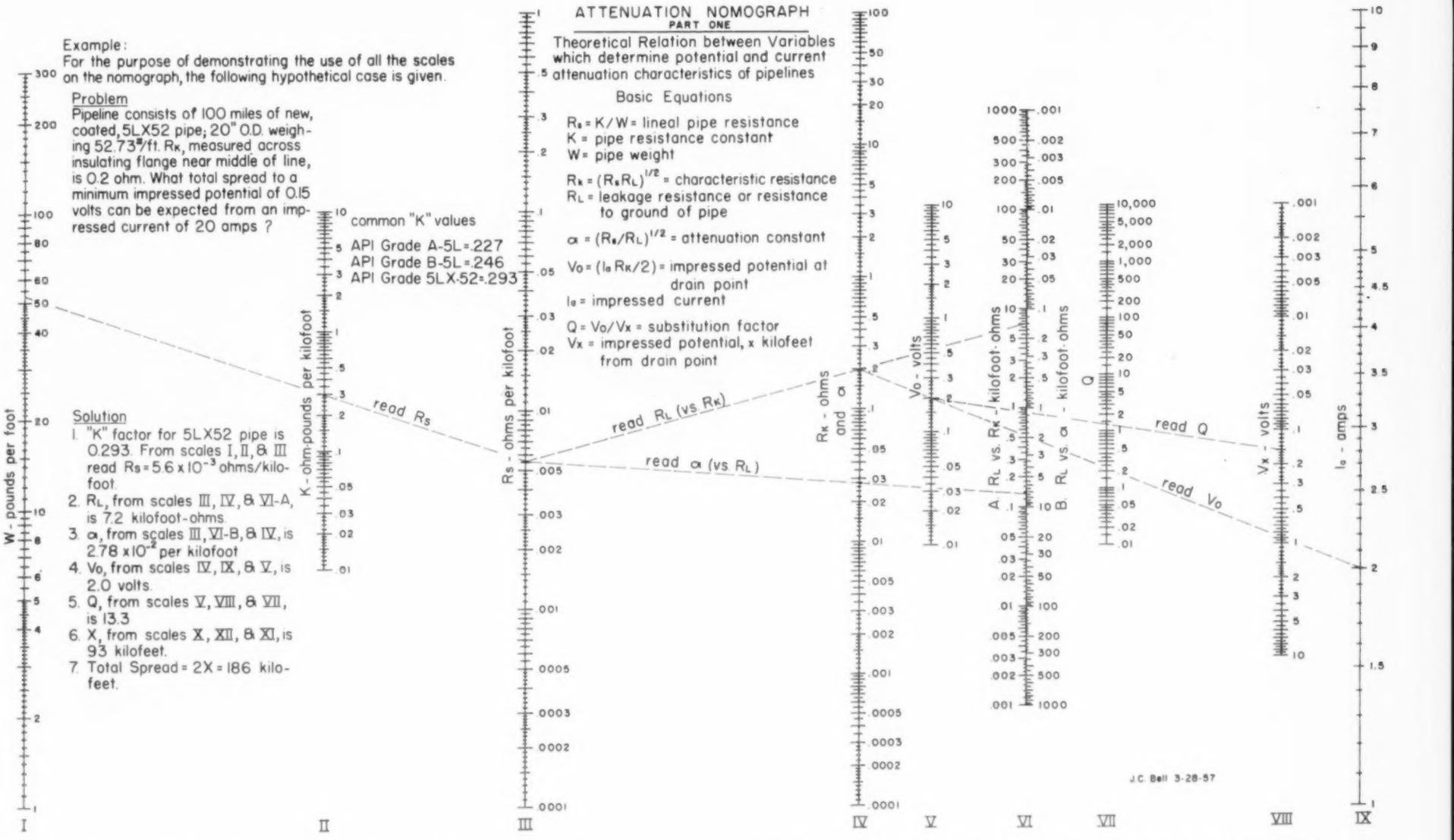

ATTENUATION NOMOGRAPH
PART ONE
Theoretical Relation between Variables which determine potential and current attenuation characteristics of pipelines
Basic Equations
$R_s = K/W$ = lineal pipe resistance
K = pipe resistance constant
W = pipe weight
$R_k = (R_s R_L)^{1/2}$ = characteristic resistance
R_L = leakage resistance or resistance to ground of pipe
$\alpha = (R_s/R_L)^{1/2}$ = attenuation constant
$V_o = (I_o R_k/2)$ = impressed potential at drain point
I_o = impressed current
$Q = V_o/V_x$ = substitution factor
V_x = impressed potential, x kilofeet from drain point
Example:
For the purpose of demonstrating the use of all the scales on the nomograph, the following hypothetical case is given.
Problem
Pipeline consists of 100 miles of new, coated, 5LX52 pipe; 20" O.D. weighing 52.73#/ft. R_K, measured across insulating flange near middle of line, is 0.2 ohm. What total spread to a minimum impressed potential of 0.15 volts can be expected from an impressed current of 20 amps ?
Solution
1. "K" factor for 5LX52 pipe is 0.293. From scales I, II, & III read $R_s = 5.6 \times 10^{-3}$ ohms/kilofoot.
2. R_L, from scales III, IV, & VI-A, is 7.2 kilofoot-ohms.
3. α, from scales III, VI-B, & IV, is 2.78×10^{-2} per kilofoot
4. V_o, from scales IV, IX, & V, is 2.0 volts.
5. Q, from scales V, VIII, & VII, is 13.3
6. X, from scales X, XII, & XI, is 93 kilofeet.
7. Total Spread = 2X = 186 kilofeet.
common "K" values
API Grade A-5L = .227
API Grade B-5L = .246
API Grade 5LX-52 = .293
read R_s
read R_L (vs R_K)
read α (vs R_L)
read Q
read V_o
W - pounds per foot
K - ohm-pounds per kilofoot
Rs - ohms per kilofoot
R_K - ohms and α
V_o - volts
A R_L vs. R_K - kilofoot-ohms
B R_L vs. α - kilofoot-ohms
Q
V_x - volts
I_o - amps
J.C. Bell 3-28-57
I
II
III
IV
V
VI
VII
VIII
IX

FIGURE 11, 11a—This nomograph relates the variables of the attenuation equation for quick calculations. It serves as a ready means of determining the theoretical affects of any combination of variables; once any two, such as lineal pipe resistance or characteristic resistance are known, the rest can be determined.

tial is governed by resistance and leakage current. When considering multiple drains, the total effect of any point may be considerable as the algebraic sum of effects caused by individual drain currents (algebraic since leakage currents must be defined according to direction of flow). Then the impressed potential at any point may be considered as the product of the resistance and the *numerical* sum of individual leakage currents, regardless of source and sign.

Thus, if we install two impressed current units at different locations along a line, the impressed potential at a point "x" will be a function of current from both units, as follows:

$$V_x = (I_{x1} + I_{x2})R_k \qquad (16)$$

If the two leakage currents reaching point "x" happen to be equal, as would be theoretically true at a point midway between two units draining equal quantities of current, V_x obviously would be double the value created by one unit. And as we move toward either unit from the midpoint, the leakage current reaching each successive point from the nearer unit increases; that from the farther unit decreases, with comparable effects on the impressed potential at each point. These relationships are illustrated by Figure 10.

Addition of a third unit, or more, beyond the second will lend to the total effect. However, since initial system design is based on equidistant unit spacing, and since we are usually concerned with obtaining some minimum impressed potential midway between units, the contrib-

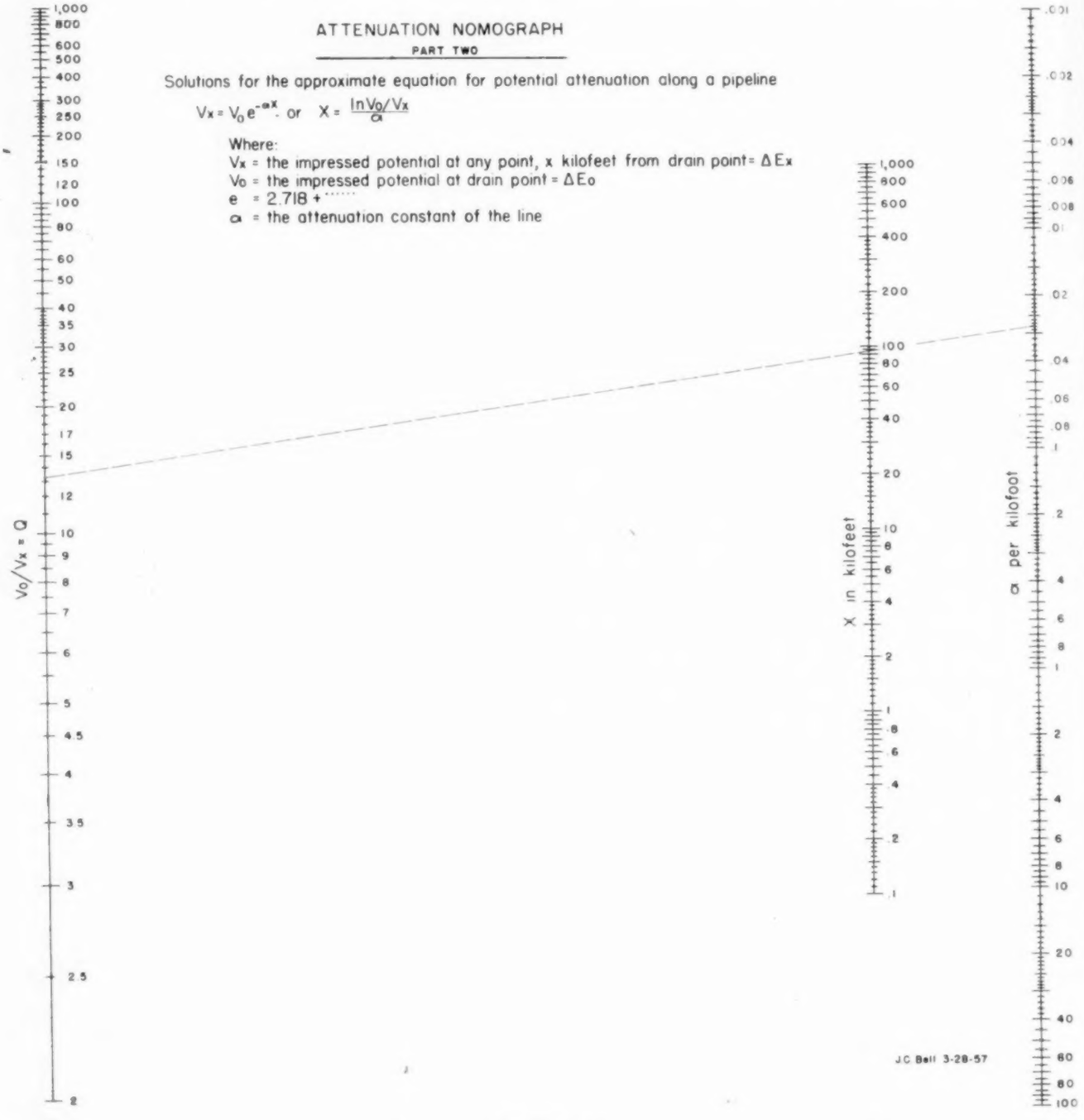
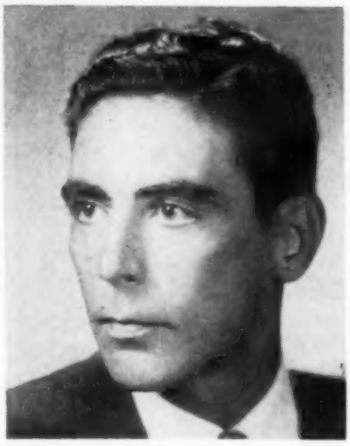

ATTENUATION NOMOGRAPH
PART TWO
Solutions for the approximate equation for potential attenuation along a pipeline
$V_x = V_0 e^{-\alpha x}$ or $X = \frac{\ln V_0/V_x}{\alpha}$
Where:
V_x = the impressed potential at any point, x kilofeet from drain point = ΔE_x
V_0 = the impressed potential at drain point = ΔE_0
e = 2.718 + ·····
α = the attenuation constant of the line
$V_0/V_x = Q$
X in kilofeet
α per kilofoot
J.C. Bell 3-28-57
X
XI
XII

FIGURE 11A



JOHN C. WATTS, Jr.
1923-1959

THESE WORDS are being written as a train rumbles through South Louisiana's winter-bleak marshland. Along the left side of the track is a pipe line right-of-way. Occasionally four lines break out of the earth to span a bayou. Up front three cars rests all this world now holds of a friend. He is returning to his native Mississippi; tomorrow, Ash Wednesday, he will be buried in Meridian.

John C. Watts, Jr., 35, engineering editor of PIPE LINE INDUSTRY died in a Houston hospital February 8 after a brief illness. Some may recall his work as an engineer with Humble Pipe Line Company where he went following graduation from Mississippi State and graduate studies at the University of Alabama. After several years of engineering duties with Humble he joined Internal Pipeline Maintenance in West Texas as Technical Director. Two years ago he became engineering editor of PLI.

John's work with several engineering and pipe line groups—the National Association of Corrosion Engineers, the Houston Pipe Liners Club, and Houston Engineering and Scientific Society plus several fraternal and social organizations won him many friends.

Facts like these you always read in obituaries. And that is good, but they don't really tell you much about a man. John developed a variety of talents well. He was a capable engineer, and his efforts didn't stop at the job he was being paid for. In the NACE, he served on several technical committees and was chairman of one on internal pipe line coatings. Just three weeks before his death he headed the publicity committee for the Houston Corrosion Short Course. He was a truthful and interesting writer.

Probably many corrosion engineers will remember his sports activities—or the results of them. Two years ago at the NACE convention in St. Louis he delivered a technical paper while on a pair of crutches. A few weeks earlier he had broken a leg on a Colorado ski run.

Actually he was an excellent skier, but most of his slow-footed friends will remember him about a hundred yards up the fairway after their tee shots. He was a sub-80 golfer.

John was a lover of good music. About a week before he died some engineers and pipe line associates in Houston pitched in to give him a $25 FM radio. From his response you would have thought it cost a million. His was a sense of delight—even at such a small thing—at that awesome time.

Character shows through on men when they face death. A visit to John's hospital room was a lesson in gentleness and humility. If you went there to cheer him, somehow you came away with more than you left. His thoughts were always of others—of his mother who devoted hundreds of sleepless hours to his care and of friends. He was especially grateful for the letters and cards sent, often he would want you to read a thoughtful note that some mutual friend had sent him. He even talked of work and getting home to edit some articles.

If there was ever any bitterness in him no one but John had to fight it. He loved the joy of life. He knew and accepted the suffering of death. To both he gave meaning. May God have mercy on his soul.

tions of more than two adjacent units may be neglected. In the event that this information is required, a graphical approach is probably the easiest solution. The problem can be solved mathematically,[3] but the process is somewhat cumbersome.

The nomograph, Figures 11 and 11A, relates the variables comprising the exponential attenuation equation for impressed potential. This graph serves as a ready means of determining the theoretical effects of any combinations of variables; once any two, such as R_s and R_k, are known the rest can be determined.

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J. M. Standring, "Attenuation of Drainage Effects on a Long Uniform Structure with Distributed Drainage," *Corrosion*, June, 1947.

TO BE CONTINUED

About the Author

James C. Bell, corrosion engineer with Service Pipe Line Company, graduated with a B.S. in chemical engineering from Purdue University in 1947. He worked as an engineer for Cooper Tire and Rubber Company until 1949 when he became a drilling mud engineer representative in Oklahoma, West Texas, and New Mexico for Bariod Sales Division, National Lead Company. He has been affiliated with Service Pipe Line Co. since 1951 and has done extensive work in the corrosion field.

Tough New Coating Can Be Tailored to Fit

Polyepoxy resin, wedded cousin of coal tar and epoxy resin, brings control of flexibility, hardness, abrasion resistance to pipe lines

By W. E. Kemp, Technical Director
Koppers Company, Inc., Pittsburgh, Pa.

By incorporating diepoxy resins and polyurethanes into coal tar a highly improved pipe coating has been obtained. This new coating—which can be described as a coal tar, chemically cured, reactive resin coating—possesses many of the desirable characteristics of coal tar, yet it exhibits freedom from deformation and flow at elevated temperatures. In addition, it has improved flexibility at low temperatures.

This discovery of a new class of epoxy compounds now provides the pipe line industry with a versatile coating that can be tailored for specific uses. To a degree its resistance to abrasion, chemical environment, temperature extremes, and impact loads associated with construction practice can be controlled.

Used on 55⅜-Inch Gas Line. A good example of the versatility of this new resin in combination with coal tar is its application for the protection of gas lines exposed to highly corrosive atmospheres and frequent temperature cycling. This coating was selected to protect the 55⅜-inch gas line recently installed by the Carnegie Natural Gas Company (Figure 1). The line runs above ground through a large steel plant where it is exposed to a highly corrosive atmosphere occasioned by the presence of numerous coke quenching stations. Over 11,000 feet of this large diameter pipe was coated with a coal tar polyepoxy resin coating and each of the 338 pieces of pipe was trucked many miles without damage. After it was welded up, it required only minor touch-up and coating of the welded sections.

Coating was applied by means of a unique semi-continuous coating application system. The spray assembly, which included a high-pressure pump and heater, was mounted on a small car whose movement in traversing the length of each pipe section was coordinated with the speed of rotation of the pipe. The magnitude of the operation is illustrated by the photographs.

Other Special Applications. Many other applications which take advantage of the unique properties of this new resin in combination with coal tar include the lining of coal bunkers for large power stations to prevent erosion and corrosion by the action of moving coal; the protection of certain components in caustic soda and chlorine cells; and the coating of steel

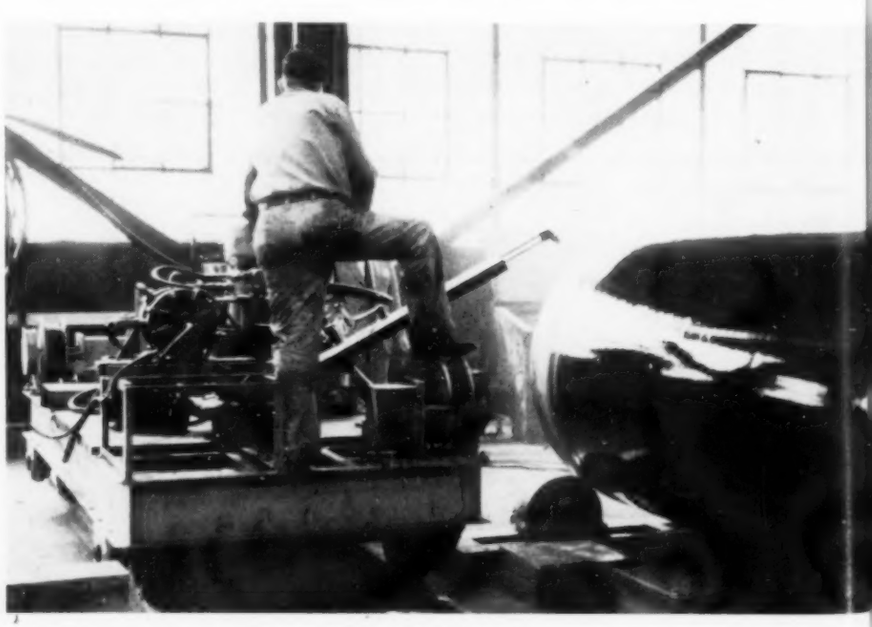


FIGURE 1—Coating the 55⅜-inch gas pipe line that runs from U.S. Steel's Clairton, Pa. coke oven plant to the Homestead District steel works at Munhall, Pa. The joint spins and this geared and synchronized truck carrying a high ratio barrel pump, heater spray rig and coating reservoir applies the coating to the giant sized pipe.

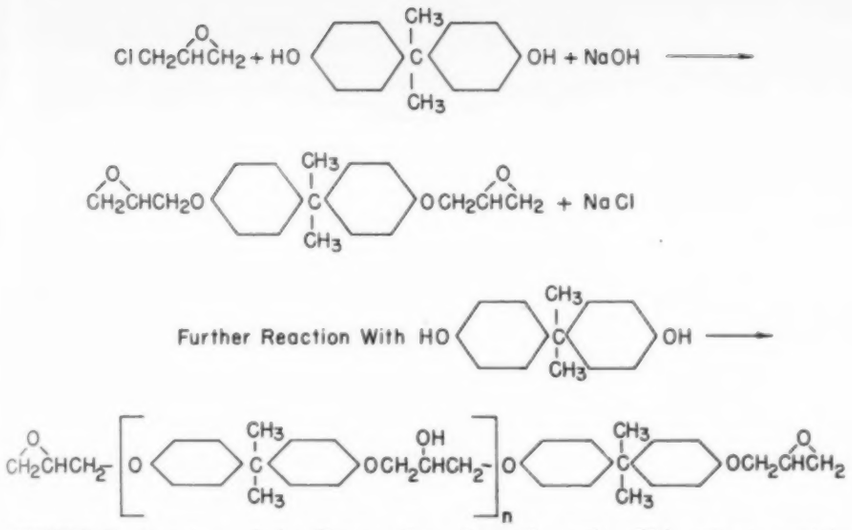


FIGURE 2—Structure of the diepoxy class of reactive resins. This polymer contains an ether linkage between the benzenoil and the aliphatic hydroxyl groups in the paraffin chain.

stacks where temperatures as high as 400° F. are reached.

Chemical Structures of Diepoxides and Polyepoxides. Figure 2, which illustrates the structure of the diepoxy class of reactive resins, should be contrasted with Figure 3, which illustrates the structure of the polyepoxy class of resin. The chemist will readily note that they are two quite different chemical species.

The diepoxy polymer contains an ether linkage between the benzenoid structures and aliphatic hydroxyl groups in the paraffin chain; whereas in the polyepoxide polymer the benzene rings are linked by carbon to carbon bonds and contain no aliphatic hydroxyl groups in the paraffin chain. There are additional points of difference:

- The diepoxy structure is limited to a maximum of two epoxy groups per molecule. The novolak polyepoxy structure may contain any number consistent with solubility considerations.
- Either before or after reaction with epichlorohydrin the basic polymer structure of the novolak may be modified by reaction with other compounds to tailor and to fit the final reactive resin product to the end use desired.
- Mono primary amines cannot crosslink the bifunctional diepoxides, whereas they can be employed to crosslink the polyepoxides.

What These Chemical Structures Mean to the Pipeliner. On the surface it may appear that these chemical differences are only of interest primarily to the organic chemist. In reality, they are extremely important to the formulator of protective coatings and the consumer. They greatly enlarge the scope and freedom of the ultimate consumer in specifying the degree of hardness, flexibility, abrasion resistance, chemical resistance, impact resistance, and other physical and chemical properties which are important, to him for his application.

Pot Life Important. For example, entirely different considerations of pot life and cure time are important to a coating applicator in Texas in the summer months, and another applicator in the Alberta oil fields of Canada where the ambient temperatures may differ as much as 50 degrees. The high degree of functionality of the polyepoxy resins permit the selection of curing agents which will provide satisfactory pot life at any temperature from 40° F. to 120° F. and obtain the same degree of cure.

An equally wide choice of curing agents to fit and tailor the pot life of coatings based on diepoxy resins is not available. Similarly, the degree of hardness of the cured coating may be varied easily over a very wide range, from glass hard to soft and ductile, using the polyfunctional polyepoxides and a suitable curing agent to obtain the desired rigidity.

Offshore Applications. One outstanding example of the use of the new polyepoxy in combination with coal tar is the protection of steel piling and similar steel structures continuously immersed in sea water and subject to attack by barnacles and other marine organisms. It is impractical to protect such structures through the use of anti-fouling paints because of their relative short life caused by leeching of the toxic agents. Similarly, the protection of steel in continuous sea water immersion by means of unmodified coal tar enamels or similar soft coatings is impractical because they are readily penetrated.

The polyepoxy resin modified coal tars can be formulated to such a degree of hardness after curing that they will completely prevent the penetration of marine life. Figure 4 shows a steel panel coated with a coal tar polyepoxy resin coating which had

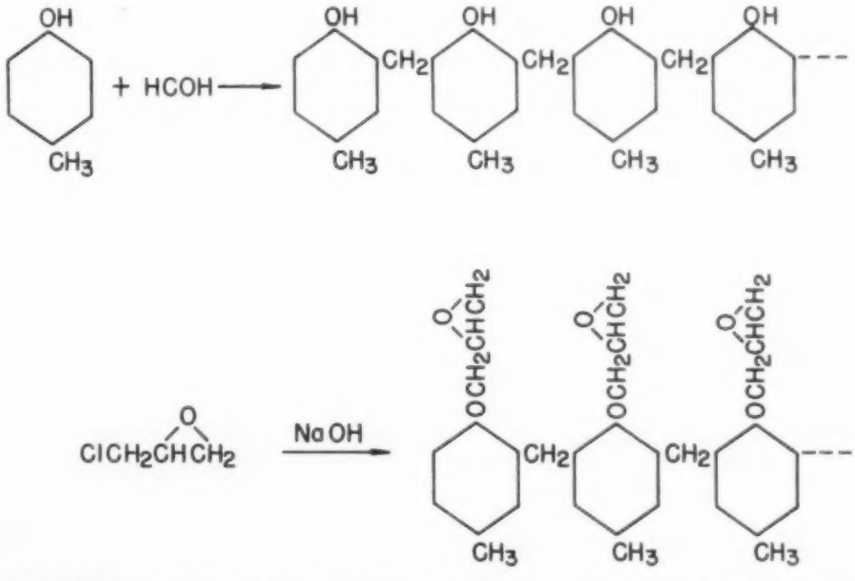


FIGURE 3—Structure of the polyepoxy resins. The benzene rings are linked by carbon to carbon bonds and contain no aliphatic hydroxyl groups in the paraffin chain. This means longer pot life.

FIGURE 4—Steel panel protected by a coal-tar polyepoxy resin after two years in the sea. The marine fouling has completely covered surface of the coating.

FIGURE 4a—Same panel showing heavy marine fouling partially removed with steel scraper. Note the high gloss and absence of barnacle penetration and rusting.

been continuously immersed for over two years when a section of the heavy fouling was removed by chipping with a heavy steel scraper, the coating was unperforated, and it retained its original finish.

Future. The versatility of this new class of chemically cured resin has not yet been fully explored. It appears that there is a distinct possibility that coatings based on further modifications of the polyepoxy resin molecule and cured at room temperature will, for the first time, exhibit physical and chemical resistances equivalent to those obtainable from baked coatings.

—**The End**

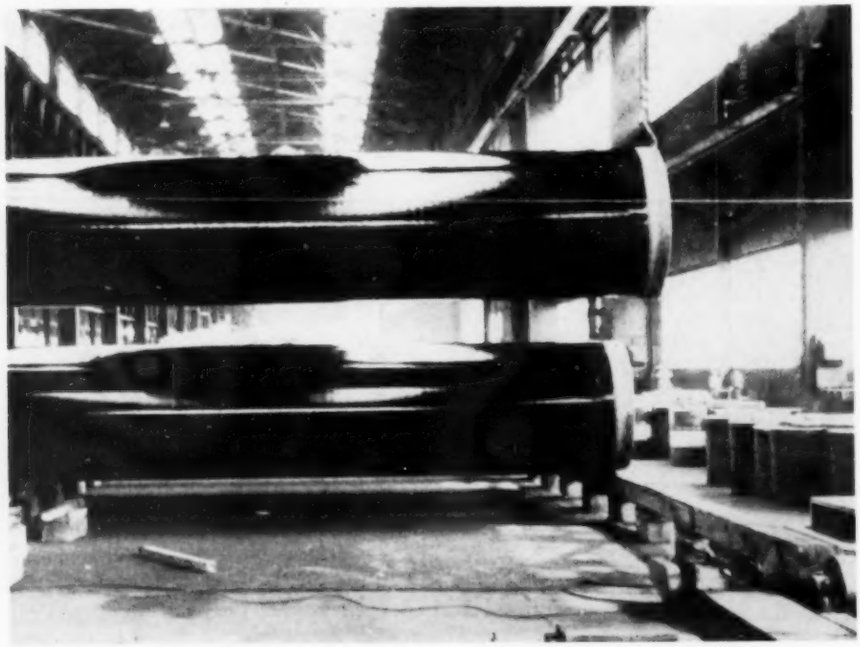


FIGURE 5—Glassy finish of the finished sections of 55⅜-inch pipe after it comes from the coating machine. Pipe size is emphasized by the 55-gallon drums at right.

About the Author

Woodrow E. Kemp, Koppers Company, Inc., technical director-coatings, is a graduate of the University of Toronto. His early experience was in the vegetable and petroleum oil industry as an employe of Lever Bros. and the Anglo-Scottish Oil Co. He became interested in coal tar chemistry and joined Dominion Tar and Chemical Co., Montreal where he served as senior research chemist until joining Koppers. Kemp is a Fellow of The Chemical Society and a member of the American Chemical Society, AAAS, AIM and NACE.

Advances in Rectifiers Solve Protection Problems

Cathodic protection rectifiers have been greatly improved as has our technique in using them

By Troy R. Stilley, General Manager,
Electrical Mechanical Division,
Good-All Electric Manufacturing Co.
Ogallala, Neb.

TECHNICAL IMPROVEMENTS are coming so fast these days that when we find a pressing problem we can almost sit back and wait a month or so, and the solution will be forthcoming from one of our many laboratories or engineering departments. Certainly in the field of cathodic protection rectifiers, we have experienced a number of innovations which have reduced the cost of erstwhile expensive equipment while greatly increasing its efficiency.

At the same time, our technique in applying rectifiers to some of our problems in the field is improving. Before we go into some of the complex engineering developments pertaining to the rectifiers themselves, let's take a look at two problems which at first appeared to be complex, but can be solved quite simply by the correct application of rectifiers.

Problem: Stray Currents.

Possible solutions to the problem. Those who have dealt with the electrical aspects of corrosion control have been exposed to the problem of stray currents. In most cases, the solution will fall into one of the following categories:

1. Eliminating the stray current by locating faulty connections in the interfering circuit or some such other method.
2. Over-riding the interference with sufficient cathodic protection current to cancel all the harmful effects.
3. Bonding the structure being affected to the most negative part of the interfering current.

Let's discuss the third method—that of bonding the structure to the most negative part of the interfering circuit. If the interfering source of current is steady and undirectional, this problem is not very complicated because a resistance bond can be used and the resistance of the bond can be changed to compensate for the interference.

In many cases, however, the interference is variable and often may be reversing. This is particularly true if the origins are trolley systems, mines, etc. For these installations, we must use a bond which will allow current flow through the bond (when the direction of flow is such that it will provide protection for the structure) and interrupt the flow of current when it tends to reverse.

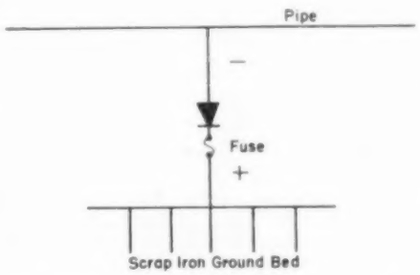


FIGURE 1—Using a half wave rectifier stack to protect a line. No outside current source is required: the stray AC current is sufficient. Note that the ground bed is scrap iron rather than graphite. The reason is that the potential between graphite and the steel pipe would be 2 to 2½ volts.

Using an automatic switch to solve this problem is the normal solution. We can set it to close automatically when the current flow is in the right direction and to open when the current reverses. The difficulties with switches of this type are their many short life components and their expense.

Half-wave rectifier stacks provide the best solution. These units are simple, inexpensive and reliable. In the early days, this method was not accepted by most engineers because they thought the resistance of the rectifier stacks would be too high and the voltage drop in the stack would cause a potential on the structure which would still leave it subject to corrosion. However, these fears proved groundless in most instances as evidenced by the installation described below.

Typical application of a half-wave rectifier. Let us suppose we have a section of pipe line which is picking up 100 amperes of stray current and we wish to bond it to a negative buss on a trolley system in such a manner that the pipe-to-soil potential will not shift more than one-tenth of a volt. If we apply Ohms law to this prob-

lem, we find that one-tenth of a volt divided by 100 amperes would mean that the resistance of the bond would have to be 1/1000 of an ohm. The resistance of a selenium stack, which we might insert in this bond, would be approximately 2/100 of an ohm. Our first assumption would be that the shift in pipe-to-soil potential would be enough to cause stray current corrosion. However, a selenium stack has been used in several applications of this type and in most cases it has been found that when the bond with the stack was added, the potential of the pipe line was always shifted in the protected direction instead of in the direction which indicates stray current corrosion.

An investigation of this shift in current revealed that in most cases there was enough stray AC current in the ground to supply power and that selenium stacks would rectify it. In a sense this was providing free cathodic protection current for the pipe line.

In addition to overcoming the voltage drop in the stack with rectified power from the stray AC current, the hookup provided an inexpensive bonding connection which would allow current to flow in only one direction. At the same time, the equipment was made up of components that were virtually trouble-free. It should be added that the fuse on the unit was somewhat oversized to take care of minor current surges.

Free current is often available. In many cases you will find that this stray AC current on a pipe line is sufficient to supply all of the power needed for cathodic protection. There are a number of installations where a well coated pipe line is being protected by installing a ground bed and connecting a selenium stack between the ground bed and the pipe line. Thus all of the AC power is supplied by induction from ground systems and current-carrying high lines over the pipe line.

This seems an excellent way to use some free power to obtain cathodic protection. If you decide to try this, you will find that a scrap iron ground bed will work better because the potential between the scrap steel in the ground bed and the steel in the pipe line will be zero where you would be bucking a 2 to 2½ volt potential if you used a graphite ground bed. Figures 1 and 2 show typical circuits which are used to control and utilize stray AC and DC currents for cathodic protection.

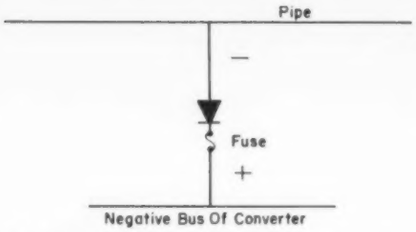


FIGURE 2—Protecting a pipe line against stray DC current, using a half wave rectifier stack to prevent current flow in the wrong direction. The resistance of the selenium stack will, in most instances, be overcome by stray AC current.

Probiem: Protecting Meter Switches. This is a tough problem. If you are a corrosion engineer, chances are you have had the experience of pushing the ammeter switch on a cathodic protection rectifier to determine the current output of the unit, only to find that the pointer on the meter would not make two consecutive readings of the same value. Push the button four or five times, and the reading starts to repeat. The cause of the variation is resistance of the corroded contact points of the meter switch.

This difficulty has caused many engineers to specify that the meter switches be left out of cathodic protection rectifiers with the result that the meters are sometimes severely damaged by nearby lightning storms. This has been a subject for much controversy in many groups, and investigations into switchgear have failed to eliminate this trouble. The resistance of an ammeter shunt is so low that it is very difficult to find an ammeter switch which will have a contact resistance low enough to avoid erroneous readings even when the switch is new, much less after it has developed corrosion on the contact.

Solution: Short Circuit Ammeter When Not In Use. This problem does not exist in voltmeter circuits because the resistance of the voltmeter is very high compared with the contact resistance of the switch. The error which is introduced is negligible. We have solved this problem by using a circuit as shown in Figure 3 where the ammeter is shorted out when not in use and the contacts are open to allow the ammeter to read when the button is pushed. Since the resistance of an ammeter shunt is very low, it is very difficult to short out. Therefore, we have found it necessary to have the two shorting contacts, shown in Figure 3, to accomplish this. Even with two shorts, there will be a small reading on the ammeter which is normally in the order of 2 to 3 percent of full load reading. However, the ammeter will read accurately when the button is pushed because there are no switch contacts in the circuit.

The only problem involved is in zero-setting the ammeter. This must be done very carefully when the rectifier has been disconnected.

This new circuit will eliminate all of the erroneous readings in ammeter which are caused by the resistance of switch contacts.

Developments in Rectifier Controls. One of the most worthwhile new developments in cathodic protection rectifiers is a reasonably priced constant current unit which is now available from several manufacturers. In 1954 a $300 unit would cost $2,500 if it had constant current controls. Today the same unit costs approximately $450 complete with the controls.

At a cost of only $150 for constant current controls, payout is quick for installations in remote spots where it is inconvenient to adjust the units for changing weather conditions or changing conditions in the ground bed. The latter may be occasioned by infiltration of brackish water, waste disposal, etc.

Example. Let us suppose for example, that you have a rectifier installed where an attendant must travel ½ mile each day to adjust the rectifier for changing conditions. This will take approximately 15 minutes per day, which may sound insignificant, however, you will find that if you estimate the cost of the man and his truck at only $3 per hour, the extra cost comes to $150 for a 200-day period. Thus the constant current control will pay out in a little less than seven months.

The constant current controls described here have no moving parts. They use reactors for control giving them a high degree of reliability and a long life as well. As a matter of fact, these units may actually increase the life of the rectifiers through its prevention of overload and short cir-

cu t difficulties. The reactor controls also eliminate many contacts such as tap switches which can cause trouble.

Specifying controls. Care should be taken in specifying the type of contacts to be used when tapped transformers are used. You will find that link bars or some such high pressure contact are much more dependable than tap switches and such devices which have low pressure contacts. Silver plating of all such contacts is very helpful. Tap switches should be used at a rating which is not more than half of that normally used for most commercial applications. Rheostats and other variable resistors should be avoided whenever possible, not only because of contact trouble but also because of the loss of efficiency in the form of rejected heat.

Characteristics of the units. Most units are designed to control current values to plus or minus 10 percent of a specific setting. In addition there are other units which control within one percent of the setting. But the newest development, which promises to be of great use for a number of special applications is a "special curve unit" which will control the current within different ranges for varying conditions. An example of its application would be a dock where current requirements change with water conditions. It is possible that changing tides could double current requirements—and at the same time, reduce the resistance of the ground bed to one-fourth its former value. This would mean that with the conventional constant protection rectifier, the current would increase to four times the regular setting while the requirement is only double the regular setting.

A rectifier could be built with a control reactor which would allow the current to double when the resistance of a circuit is changed to ¼. Units of this type are somewhat more expensive than a straight constant current rectifier. Still, they can quite often be justified, and they are much less expensive than units which control a pipe-to-soil potential or structure-to-water potential.

Higher Voltage Selenium Plates and Silicon Diodes. In recent years, selenium-plate AC inverse ratings have been increased from 26 volts to 45 volts root-mean-square, and silicon diodes are now available with inverse peak ratings up to 600 volts.

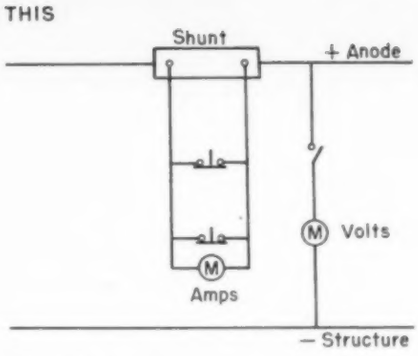


FIGURE 3—The correct way to wire up a meter switch to avoid trouble from corroded contact points. Ammeter is shorted out when not in use. Push the button and contacts open to allow the meter to read.

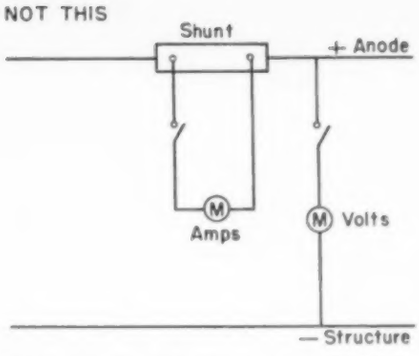


FIGURE 4—Old way of hooking up meter. When the button is pushed, the resistance of the contact points will cause a variation in readings—usually for four or five times. Better hookup is shown in Figure 3.

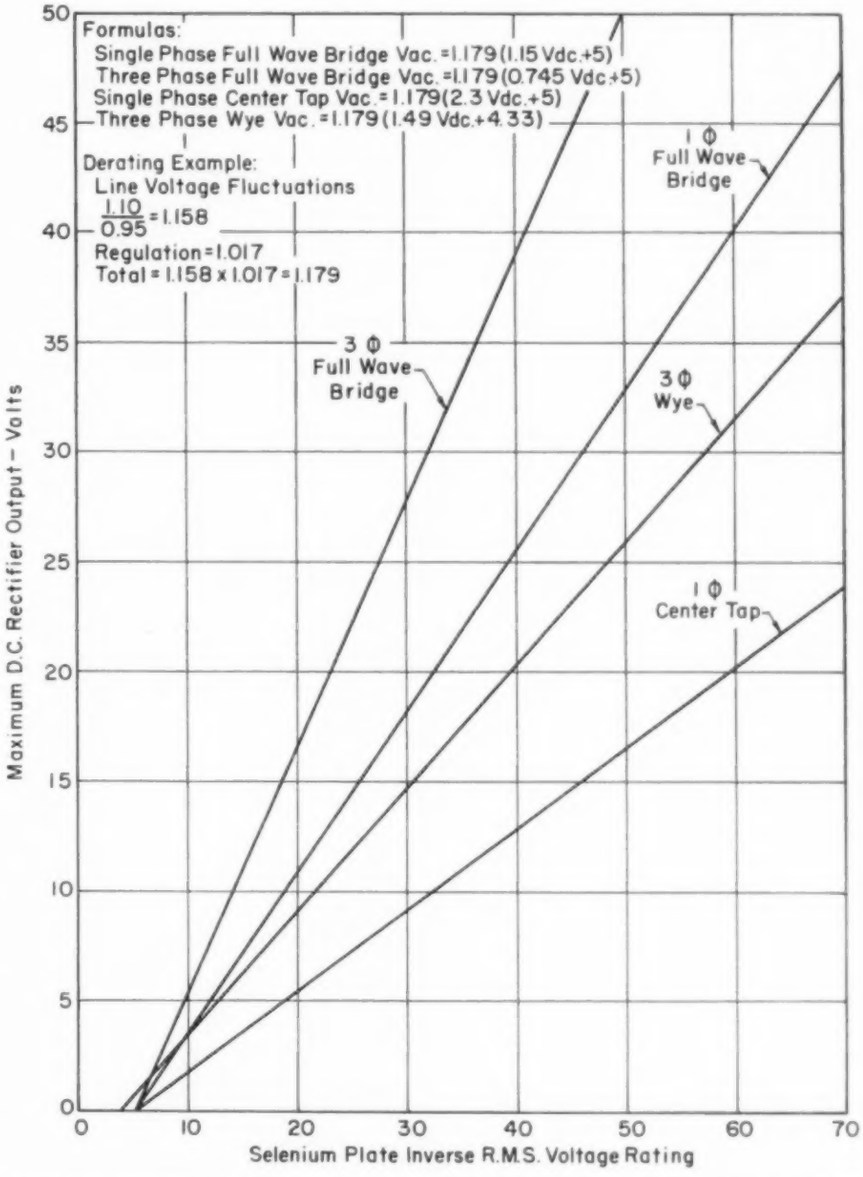


FIGURE 5—Maximum DC rectifier output in volts plotted against selenium plate inverse root-mean-square rating. In the example problem, input AC was 110 volts and output DC was 95 volts. Transformer regulation was about 1.7 percent giving a factor of 1.017. Total derating factor is 1.158 × 1.017 = 1.179. To find AC current for given DC output, add the 5 volt stack drop and multiply by 1.179.

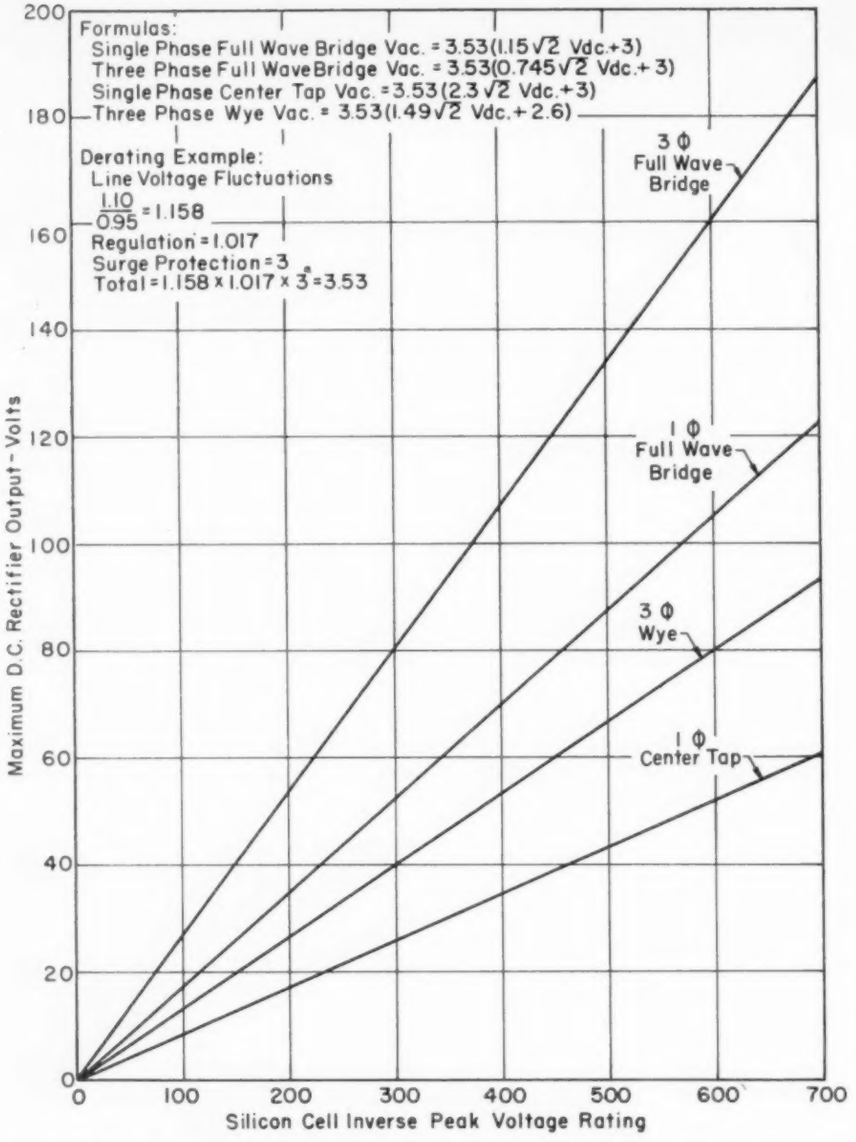


FIGURE 6—Maximum DC rectifier output in volts plotted against silicon cell inverse peak voltage rating. To prevent surges from destroying the silicon diodes a derating equal to three times that of selenium must be used. To destroy selenium plates, the surges must have a duration long enough to cause destructive overheating. However, a surge which lasts only a fraction of a cycle is sufficient to destroy the diode, and they must be derated to the point where surges will never exceed their inverse peaks.

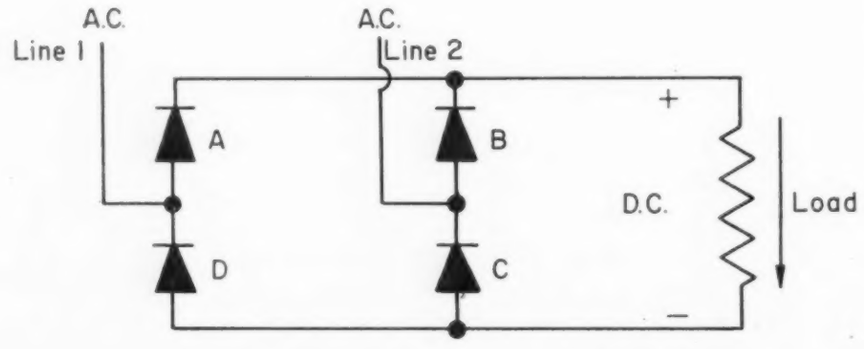


FIGURE 7—Schematic for full wave, single-phase bridge.

The high voltage silicon diodes and higher voltage selenium plates have caused rectifier designers to change their approach to circuits and designs.

To understand this problem, let's take a look at the relationship between maximum AC current applied to a rectifier bridge as related to the available DC output from such a bridge. National Electrical Manufacturers Association standards for cathodic protection rectifiers hold that all units must be able to put out a DC voltage equivalent to 95 percent of the nominal AC input voltage with fully aged stacks. It goes on to say that the unit must operate continuously when the line voltage is at 110 percent of nominal at full output. Refer to the derating formulas on Figure 5, and you will note that this requires a factor of 1.158 (110 divided by 95) for line regulation.

Because the transformer regulation will be slightly under two percent, the 1.158 factor must be multiplied by 1.017 to find the total factor. In this instance it would have to be 1.179 to allow for regulation variances for both lines and transformers.

For example, when the voltage drop in a selenium single-phase bridge exceeds five volts per cell in series, the bridge has aged to the point that its useful life can be considered expended. The voltage drop in new cells will be approximately half this value. Five volts must be added to our derating from AC to DC.

Where AC power is measured in terms of the rms valve of the wave and the DC power in terms of its average value, we find that the AC voltage applied without any drops or losses in a single-phase bridge would be 115 percent of the DC voltage available at the output.

Actual calculations. If we combine all these factors to obtain a given DC output, we must multiply the DC voltage by 1.15, add the 5-volt drop in the stack and multiply the result by 1.179 to obtain the AC input voltage necessary to obtain the desired DC output from a full wave single-phase bridge.

Selenium plates are available in production quantities with a maximum AC input rating of 45 volts. You will note from Figure 5 that this will produce 28 volts DC in a single-phase bridge and 44 volts DC in a three-phase bridge. If we attempt to obtain more DC output than this, the result will be stacks which will fail

About the Author

Troy R. Stilley is general manager of the Electrical-Mechanical division of Good-All Electric Mfg. Co., Ogallala, Nebr. He has held this position since 1956 when he left Illinois Power Co. where he was corrosion and standards engineer. Stilley was graduated from Marquette University in 1947 with a degree in electrical engineering. He became an instructor at the university and studied law for a year. He joined the staff of Shell Oil Co. at Wood River refinery in 1948 where he worked for two years. Stilley was in the U. S. Navy in World War II.

from line voltage fluctuations and surges.

A single-phase center tap circuit, as shown in Figure 9 and a three-phase Wye as shown in Figure 10, can be used instead of a bridge and the result is half as many stacks with lower cost, half the stack losses, and higher efficiencies than those found in bridge circuits. A single-phase center tap circuit with one 45 volt cell in series would produce 14 volts DC instead of 28 and in a three-phase Wye with one 45 volt cell would produce 22 volts DC instead of 44.

If we use these circuits at voltages higher than 14 volts, single-phase or 22 volts, three-phase, we lose the advantage because the AC inverse voltage is double requiring twice as many cells in series. Thus, we would end up with the same number of cells as we have in a bridge. Below 14 volts, single-phase and 22 volts, three-phase, these circuits can end up with a lower cost per unit and a much higher efficiency.

Silicon diodes are available with inverse peak voltage up to 600 volts, therefore, these circuits are applicable in almost all cases where silicon is used. Figure 6 shows the DC outputs available for silicon with various inverse peak voltages.

Experience with silicon in the last year has shown that a voltage derating equal to approximately three times that amount for selenium is necessary to prevent surges from destroying silicon diodes. To destroy selenium plates, voltage surges must have a duration long enough to cause over-heating to destroy the selenium. However, with silicon, a surge need only last for a fraction of a cycle to destroy the diode, therefore, they must be derated to the point where surges will never exceed their inverse peaks. Also, various surge absorbing devices must be used to assure continuity of service with silicon diodes.

However, the lower cost, higher efficiency, and negligible aging of silicon diodes makes them desirable in many cases, particularly where higher DC voltages are involved.—**The End**

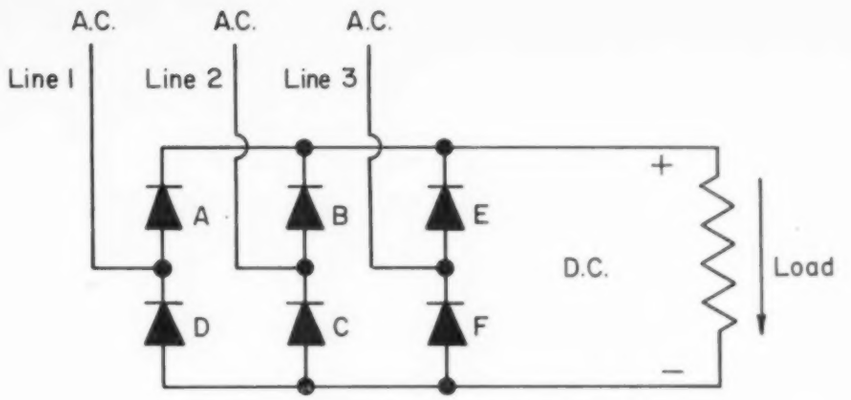


FIGURE 8—Schematic for full wave three-phase bridge.

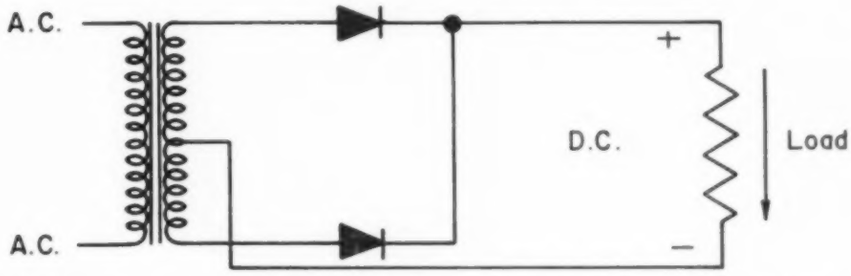


FIGURE 9—Schematic for single-phase center tap circuit which requires fewer stacks than the circuit shown in Figure 7. Stack losses are half.

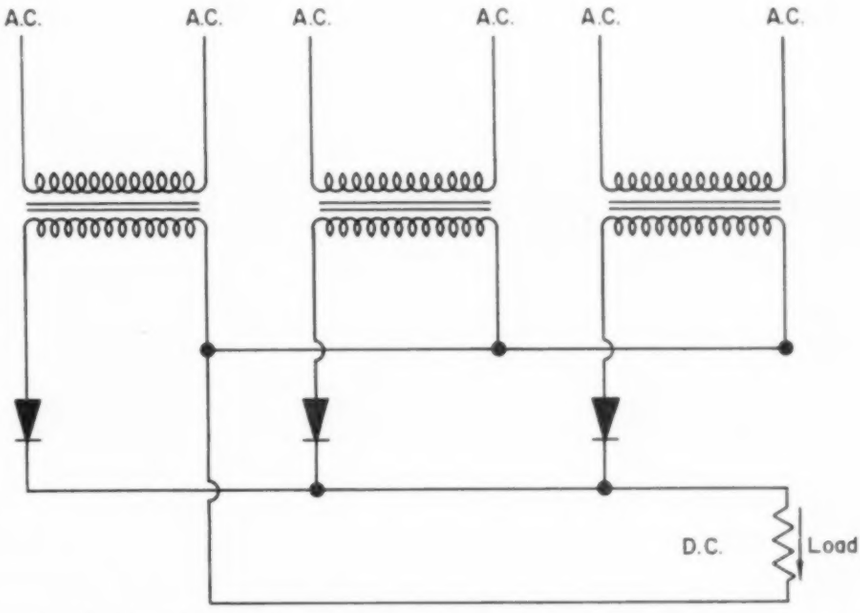


FIGURE 10—Schematic for three-phase Wye which requires only three stacks as compared with the circuit shown in Figure 8. Stack losses are half for the simple reason that there are half as many stacks.

FIGURE 1—Removing the radioactive source from the lead ball prior to inserting it into the "stinger" on the carrier pig. Note the remotely controlled pliers the operator is using.

Keeping Up With the Pigs

Radioactive tracers provide the best means—but there are necessary safety precautions to observe

By William T. Theis
Internal Pipeline Maintenance Co., Odessa

NORMALLY, THE TRAVEL and recovery of pipe line pigs can be accurately planned and carried out. However, there are innumerable operations for special purposes—especially those of cleaning up highly contaminated lines, or searching for unknown obstructions —which are highly unpredictable if ordinary methods are used for locating and removing the pig.

Radioactive Tracers. The necessity of keeping absolute track of pigs used for such special purposes has brought about the development and use of radioactive tracers. This operation employs a pig carefully adapted to the job to be performed. Attached to it is a special holder into which a sealed radioactive cobalt 60 source can be inserted.

The radiation source is a small piece of irradiated cobalt wire, in the order of 360-400 millicuries, permanently incased in a special stainless steel holder. Because of its very small size, the latter is re-incased in a larger machined steel case better adapted to field operations. This assembly is at all times, when not in actual use, kept locked in a heavy lead carrying-case providing adequate protection for transport and storage.

Tools required for using this source include a remotely operated pair of pliers and a set of long handled wrenches for capping the source holder which is previously attached to the unit to be employed in pigging the line.

As shown in the accompanying illustrations, the pig is placed in the end of the line and the source inserted in the holder or stinger, using the special pliers. Simple probes are used to move the unit down the line a short distance so operating personnel can close the trap or loading barrel and start the run.

The exact location of the pig can be determined at any time by the use of radiation counters—either the geiger tube or scintillation meters. One or two types of specially adapted geiger tube units of simple design have been found to be very effective.

Multiple Monitoring. Actual operations performed on many cross-country lines have shown that multiple monitoring at prelocated check points, using a leap frog plan, permits of pinpointing the travel of the pig. This eliminates the possibility of overexposure to the radioactive source which could come from walking the line in

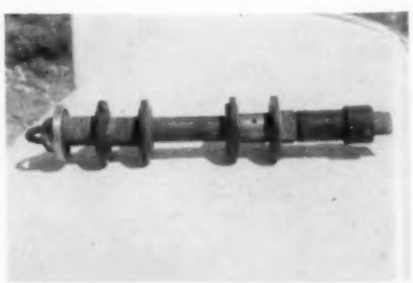


FIGURE 2—A four-inch pig ready for the insertion of the radioactive cobalt 60 source. This pig can be located inside a line at almost any depth by Geiger counter of scintillation meter.

FIGURE 3—Using remotely operated wrenches to place cap on the "stinger" or source holder after inserting the radioactive source. The latter is an irradiated cobalt wire with a radiation strength of about 400 millicuries.

close proximity to the pig. If normal estimated arrival times are exceeded, a sample back tracing search soon locates the source at the point where the pig's forward travel was stopped by constriction or obstruction.

Effectiveness. It is possible to locate a stopped pig within inches, even under 6 to 8 feet of normal backfill. Large rocks can give unpredictable readings, but only to the extent that a more careful reading of location must be made after preliminary uncovering work is accomplished. This permits correction of the location of the pig and source of the hangup within 1 or 2 inches.

Removal operations have been well standardized so that the source can be quickly returned to the lead container when the pig is removed from the line. This minimizes the radiation danger to personnel of owner or service company.

Safety in Handling. Detailed safeguards for all operations in general will be initially established as a necessary prerequisite to the special license issued by the Atomic Energy Commission for the ownership and use of the Co-60 source.

A periodic check of operations and storage of the source is maintained by AEC personnel. In addition, all persons who use the source are provided film badges which must be forwarded to Richmond, Calif., where they are developed and read weekly by a tracer laboratory.

Variety of Uses. Pigs equipped with radioactive tracers are finding many uses on pipe lines today. Ordinary pigs hang up on sand and mud in new lines and there are cases where the cups on pigs wear off to such a degree that it remains motionless in the bottom of the line despite accelerated pumping. Often the trace pig will dislodge a stuck pig and bring it to the trap with little difficulty. Other times the line must be cut.

For the most part, this operation is absolutely safe—and its convenience and accuracy will doubtlessly lead to greater applications in the future.

—**The End**

FIGURE 4—Back tracing to locate a buried line in rocky terrain. The operator is carrying a special Geiger counter. Operators are cautious about following too close to the radioactive tagged pig.

About the Author

William T. Theis of Internal Pipeline Maintenance Company of Odessa, Texas, is an engineering graduate of Kansas State University. He did post-graduate work in engineering economics of structures and construction. Prior to World War II he was an apprentice engineer with Phillips Petroleum Company and during the war he was a design engineer specializing in ordnance in military aircraft. Later he became adviser to the chief engineer of the Mechanical Components Branch at Los Alamos. Prior to joining IPM in 1953 he was in ordnance research and chief engineer of a company manufacturing hydraulic and pneumatic equipment.

Charles A. Stogoski attempts the difficult job of putting tooth powder on a tooth brush by guesswork.

David J. Joyce, Jr., relies on his fingers to indentify different swatches of material.

Mrs. Elizabeth Fritz tries her hand at dialing a phone number with vision blocked off.

'Blind' Supervisors Learn Safety Fast

By Howard F. Kempsell

Esso Research and Engineering Co., Linden, N. J.

Pouring the right amount of cream into a cup of coffee blindfolded takes practice, Anthony F. Mastrocitch found.

To DRAMATIZE the penalty of accidental eye injuries, Esso Research and Engineering Co. has launched a novel safety program for 1,000 of its 3,000 employes in Linden, N.J.

Employes, meeting in small groups, are blinded by masks and asked to perform simple, everyday activities. Without the use of their eyes, they try to dial a telephone number . . . light a cigarette . . . spread tooth powder on a tooth brush . . . identify swatches of material.

They quickly learn that vision can never be taken for granted.

Primary purpose of the program is to encourage full use of safety glasses or goggles when they're called for on the job.

Last year 24 company employes suffered accidental eye injuries (none leading to blindness).

This is not a bad record. None of these injuries involved permanent eye impairment. But Esso Research and Engineering would like to push the figure down to zero if possible.

This "blind" program recently started ought to help a lot. It's impressing people that vision is priceless. You might say they're reminded all over again that you can't use false eyes like you can false teeth.

The simulated blindness program is based on special kits prepared by the National Foremen's Institute. Each kit contains a mask plus the material needed to perform the prescribed tasks blindfolded (i.e., tooth powder, tooth brush, swatches of material, etc.). A phonograph record provided by the National Foremen's Institute works a sermon on eyesight protection into the instructions on how to use the kits.

Members of Esso Research's company-wide Central Safety committee tried the unique program out on themselves before adopting it. The first group of employes to "go blind" in the interest of safety were 15 supervisors in the firm's Service division.

Said one, after removing the blindfold he'd worn for 30 minutes:

"I've never felt so helpless!"

Blindfolded group sits around conference table, listening to phonograph record which directs correct use of safety kits. Observing program is M. D. Haworth, head of firm's Service division.

Thomas E. Rush, Jr., right, chairman of the safety committee of Esso Research's Service division, and Author Howard F. Kempsell review contents of National Foreman's Institute safety kits.

William F. Stevens had trouble lighting a cigarette without the use of his eyes. Stephen R. Scheckler stands by to see that he doesn't burn himself.

About the Author

Howard F. Kempsell is an engineer with Esso Research and Engineering Co., Linden, N.J., where he coordinates company safety activities and serves as chairman of the Central Safety committee and Disaster Control committee. He received a B.S. degree in civil engineering from Virginia Military Institute—then served two years as an equipment inspection engineer with Esso Standard Oil Co., 1½ years as a U.S. Air Force ground safety director, and four years as an assistant to the refinery safety supervisor at Esso Standard Oil Co. Kempsell has held his present position since July, 1957.

By
Pipe Line
Pete

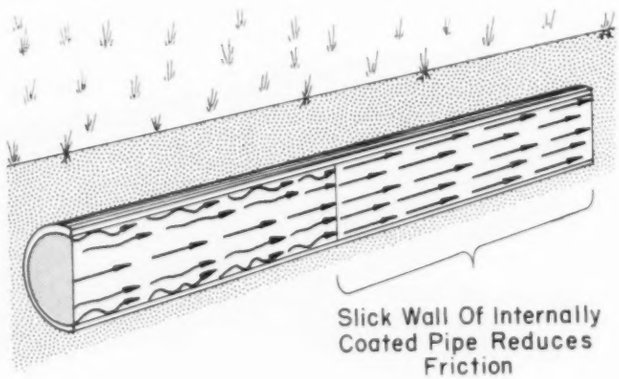
IDEAS FOR THE FUTURE!

. . . in pipe line engineering, construction and operations

Pipe Line Rumor of the Month

Internal Pipe Coating Boosts Flow Efficiencies from 4 to 13%

This is the big news of the year! Scheduled for release within a month is a report on internal coatings for pipe lines. According to reliable rumors, a slick internal coating will increase flow efficiency of a gas line from 4 to 6 percent in the average flow range. In extreme high throughput ranges, it may increase flow as much as 13 percent!



Slick Wall Of Internally Coated Pipe Reduces Friction

What does this mean, economically speaking?

Suppose it costs $200 million to lay 1,700 miles of 30-inch pipe line, install some 20 stations and establish headquarters and communications, etc. If the line delivers say 500 million cubic feet per day the cost of facilities to deliver one cubic foot of gas at the end of the line would be 40 cents. If the capacity of the line is increased 6 percent—or 30 million cubic feet—this would be the equivalent of a $12 million investment. If the cost of coating runs, say 30 cents per foot, it would come to $2.7 million for the line. Net profit to the company would be $9.3 million in facilities.

In addition, there would be a reduction in the cost of pigging and testing the pipe line.

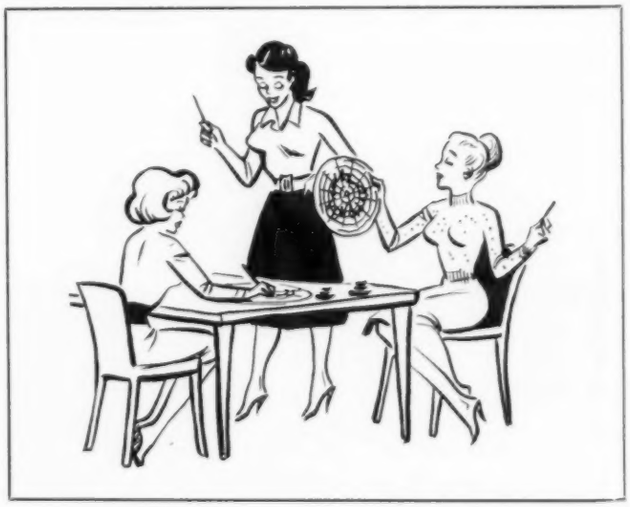
Keep in mind that these figures are purely ficticious and are based on scuttlebutt. However, it is known that tests of the internal coatings have been run at Tennessee Gas Pipeline Company's Refugio test site where the large diameter orifice plates, etc. were tested. And reports say they were highly successful!

Blondes, Brunets and Redheads Outdo Electronic Equipment

Perhaps there's a sound basis for the male eye that's prone to rove! Evidence recently uncovered by one of our large gas pipe line companies seemingly proves that while an individual female may be way off the beam, a room full of them compensate one another so well that not even an electronic computer can stand up against them!

Look what happened when an electronic chart scanner and computer tried to dislodge a group of women chart scanners from their jobs. These nimble-fingered women integrate the orifice meter charts that come in from field meters. They trace over the erratic path of the instrument pen with the stylus of a planimeter, which calculates the area beneath the curve, converting it into cubic feet of gas, etc.

Taken individually, these women are prone to err. Some register too much gas flow, some too little—de-



pending no doubt on the state of their individual affairs of the heart. Their individual errors may run as high as 5 percent!

When one of the instrument laboratories produced an electronic scanner and computer that can consistently scan a chart and come up with an answer correct to plus or minus one percent, the gas company eagerly tried it out.

But this device, accurate as it is, was no match for the wiles of a group of women. Electronically it scanned and computed the area beneath the curve etc.—to an accuracy of 1 percent—time after time. But unfortunately, its final tally also included an error of one percent!

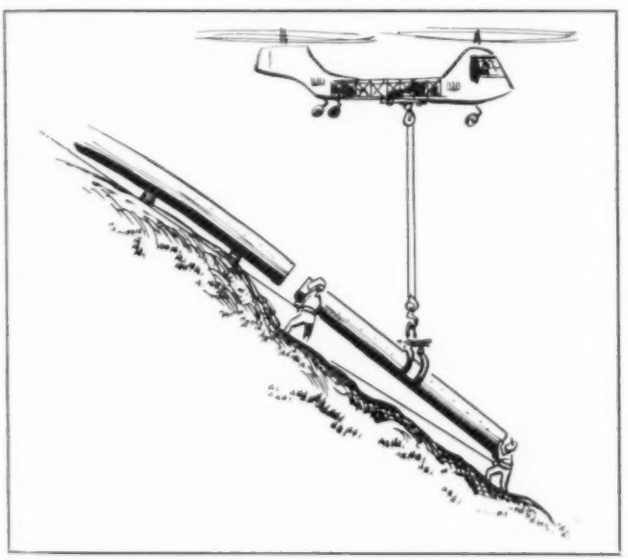
But the women—the blondes, brunets and red-heads—produced results that were right on the nose. The error in their final tally was so slight as to be negligible! Seems they compensate for one another, despite the whopping individual errors they are prone to make. In other words, their collective error is virtually zero!

The moral of this is twofold. First, an electronic gadget is no match for a group of women, and second, perfection in women probably can be achieved best through numbers. Perhaps this explains why men in olden times were able to live placidly with many wives while their modern counterparts sometimes experience difficulty in living with one of them.

So the next time you feel a twitch in your eye as a blonde walks by, just regard the impulse as a natural, and don't . . . (Ooops! I think I hear my wife calling me!)

New Helicopter Crane—A 6-Ton Skyhook for Mountain Pipelining

Practically every pipeliner at one time or another has wished for a "skyhook." Pipelining up and down steep mountain canyons and across murky swamps can intensify this wish on the part of construction men. But it is the pipe line operator who most needs the "hook in the sky." For it is one thing to pipe line across a steep mountain canyon in good summer weather, but quite another thing to make repairs to such a line in icy winter. The same holds true of swamps: it is easier to lay the line than repair it.



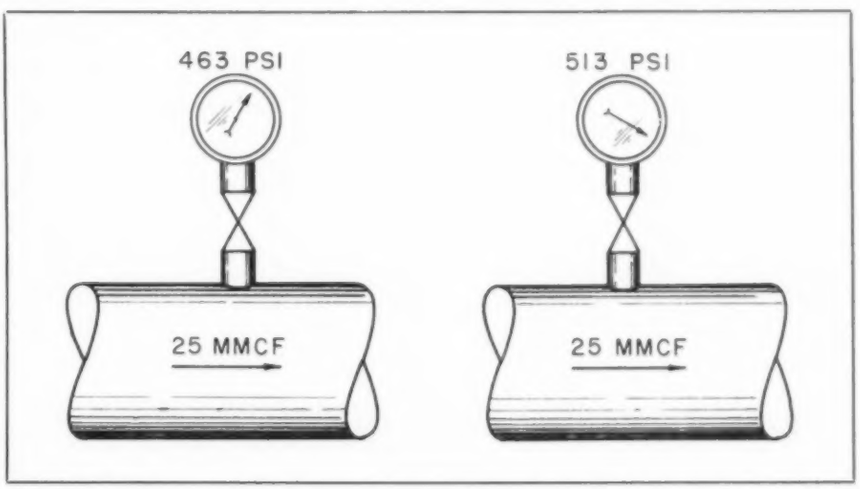
The answer to these problems seems but a short distance away. Reports have it that Sikorsky is testing a six-ton "skyhook." The new craft is a modification of the twin-engined S-60 the company developed for the U.S. Army. It will have but little cabin space—enough for the pilot and co-pilot—so approximately six tons of its lifting power will be available for moving construction equipment and tools through the sky.

Should the new aircraft prove successful, think of the new techniques that will be available for pipelining. For example, there's a new type aerial river span—consisting simply of two curved sections of pipe, leaning together—that has definite merit so far as a structure is concerned, but thus far it has defied engineers because of the difficulty of constructing it. Helicopters may provide the answer to this and many other problems.

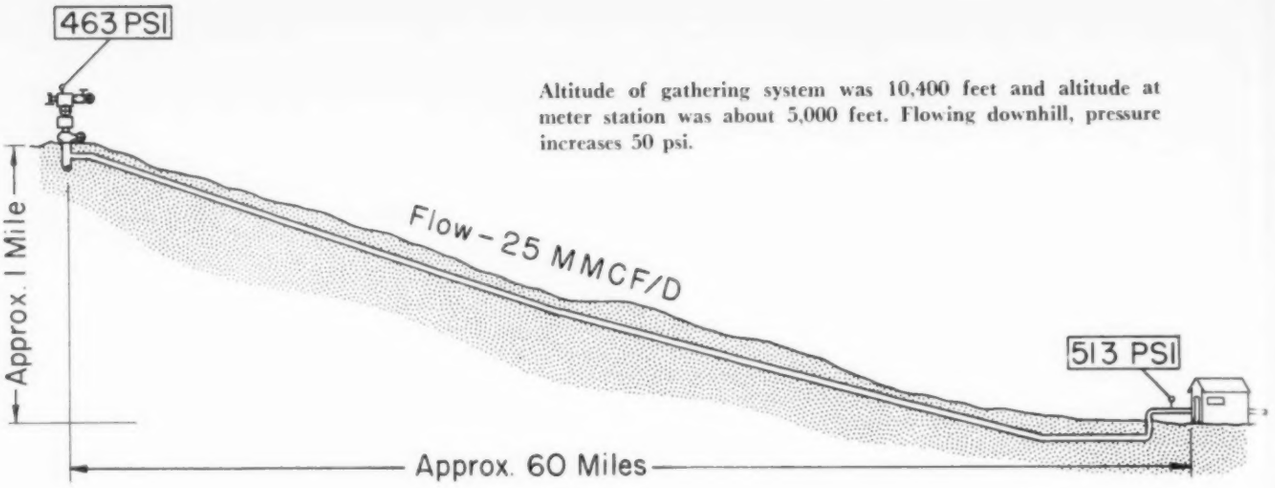
Will Gas Flow From Low Pressure to High Pressure?

(See following page)

If you know of any curious item in the pipe line field, you'd like explained—write Pipe Line Pete. He may not know the answers himself, but he sure knows a lot of smart pipeliners.



Here is the puzzler—25 million cubic feet flows from a gathering point with a line pressure of 463 psi to a meter station 63 miles away where pressure was 513 psi.



Altitude of gathering system was 10,400 feet and altitude at meter station was about 5,000 feet. Flowing downhill, pressure increases 50 psi.

Will Gas Flow from Low Pressure to High Pressure?

Yes! indeed.

When Utah Natural Gas Company's 63-mile, 18-inch line that runs from the Clear Creek field to near Provo, Utah, first went in operation, deliveries for a short time were some 25 million cubic feet per day. Flowing at this rate, the pressure at Provo—the downstream end of the line—was 513 psi, and pressure of the gathering lines was 463 psi. Thus the pressure at the delivery point was 50 psi higher than the pressure at the gathering system, and there were no compressor stations in between!

Explanation?

The altitude of the gathering system was 10,400 feet at its highest point, and the altitude at Provo was about 5,000. And gas has weight and like other fluids it will flow downhill!

In this case when the pressure at the wellheads and the pressure at Provo were the same—at say 515—the line would deliver about 60 Mmcf per day.

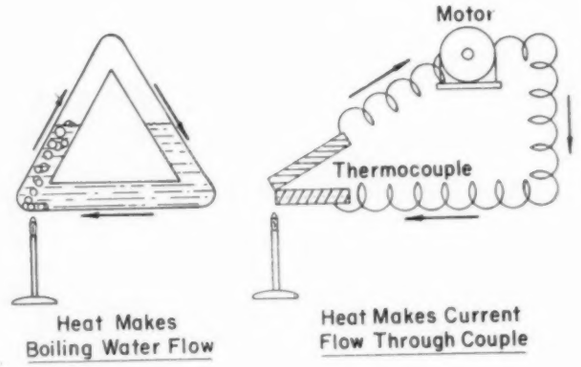
Electricity From the Atom—How It Works

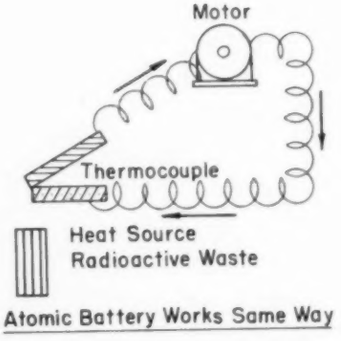
It's as simple as the thermocouple which has been used to measure temperatures for years. When certain dissimilar metals are bonded, heat applied at the juncture point will set electrons to flowing. During World War II this principle was used in making a silent power generator for radio equipment designed to operate behind enemy lines. This generator was nothing more than a series of thermocouples with a common heat source. Later, El Paso Natural used such devices to provide current for cathodic protection at three remote points where other current was not available.

Recently the Martin Company and others have developed isotope-thermocouple generators based on this principle. Using normally discarded radioactive waste products as a heat source, the thermocouples—improvements over our conventional ones—generate sizeable quantities of electricity.

Although preliminary announcements state that the device will never wear out, etc. etc., no mention has been made of the number one problem which has been encountered by others who have done work along these lines. The big question is, "How long will the devices last before shorting out because of internal corrosion?" Perhaps the new materials in the cell have solved this difficult problem.

If this is true, pipe line companies should provide ready markets not for the atom powered battery—but for the thermocouple elements to use as current generators for cathodic protection, radio etc. Pipeliners can supply the heat, quite inexpensively.





Atomic Battery Works Same Way

Rules of Thumb

and Engineering Data Sheets for the Pipeliner's field notebook

$25 for Engineering Data Sheet $15 for Rule of Thumb

These practical aids give quick, reasonably accurate answers to design, maintenance and cost estimating problems. PIPE LINE INDUSTRY will pay $25 for each chart, nomograph or data sheet published—$15 for each Rule of Thumb. Send your ideas to PIPE LINE INDUSTRY, P. O. Box 2608, Houston, Texas

Corrosion Protection

—19—Estimate the number of pounds of zinc anodes required to protect a submarine line.

To find the number of pounds of zinc anodes required to protect a mile of undersea pipe line, apply this rule. **The number of pounds of zinc anodes required per mile per year of protection will be 1.81 times the diameter of the line in inches.**

This is making the assumption that holidays comprise one percent of the coated area, that zinc has an efficiency of 90 percent and that 5 milliamperes per square foot of holiday area provides adequate protection.

Example: How many pounds of zinc anodes will be required to protect 11 miles of 24-inch submarine pipe line for 40 years?

Solution: Pounds of zinc anodes = $1.81 \times 24 \times 40 \times 11 = 19{,}114$ lbs.

Where a greater current density is considered necessary by the design corrosion engineer, or if a shorter or longer life of protection is desired, weight of metal needed for protection may be increased or decreased proportionately.

Field survey data should be taken and studied to select anode spacing and check actual protection provided to the line after installation of the cathodic protection system.

Engineering Design

—61—Estimate Weight of Pipe in Metric Tons per Kilometer

Here is a handy little rule of thumb from an Indonesian reader of PIPE LINE INDUSTRY. **To estimate the weight of pipe in metric tons per kilometer, multiply the nominal diameter by the number of sixteenths of an inch in wall thickness.**

Example: Find the weight of pipe in metric tons per kilometer for 20-inch diameter pipe, wall thickness ¼-inch.

$4 \times 20 = 80$ tons (metric) per kilometer

Actual answer from pipe tables is 79 metric tons per kilometer.

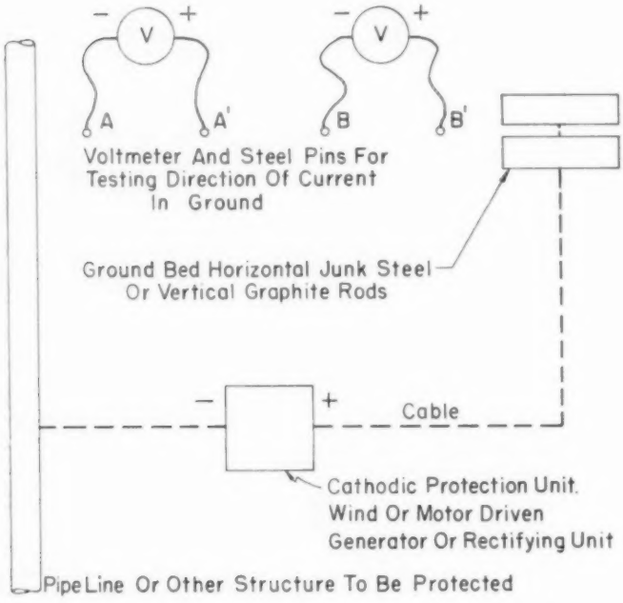
This rule of thumb is based on a density of 490 pounds per cubic foot for steel. For larger diameter thin wall pipe, this approximation gives an answer usually about one percent low. The accompanying table gives a comparison between actual weights in metric tons per kilometer, as compared to that calculated by this rule of thumb.

PIPE DIAMETER	WALL THICKNESS	ACTUAL TONS (METRIC)	R. O. T. TONS (METRIC)
10-inch	3/16-inch	31.5	30
12-inch	5/16-inch	62	60
16-inch	7/16-inch	109	112
20-inch	¼ -inch	79	80
20-inch	5/16-inch	99	100
20-inch	7/16-inch	137	140
24-inch	5/16-inch	118	120
24-inch	8/16-inch	189	192
28-inch	5/16-inch	139	140
30-inch	5/16-inch	148	150
32-inch	7/16-inch	221	224
36-inch	4/16-inch	143	144
36-inch	8/16-inch	285	288

How to do it

PIPE LINE HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1, Texas


V
A
A'
B
B'
Voltmeter And Steel Pins For Testing Direction Of Current In Ground
Ground Bed Horizontal Junk Steel Or Vertical Graphite Rods
Cable
Cathodic Protection Unit. Wind Or Motor Driven Generator Or Rectifying Unit
Pipe Line Or Other Structure To Be Protected

Use Screwdrivers to Test Polarity of Cathodic Unit

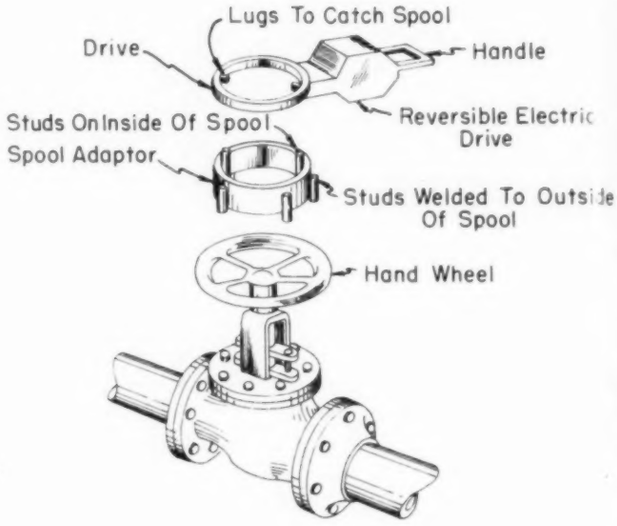
What's the worst error a corrosion engineer can make?

The answer is obvious—*reverse the polarity of the cathodic protection unit!*

For when this happens, the protective current turns to destruction and greatly accelerates the rate of corrosion.

Is there any danger of this happening? Yes, indeed! Every time the unit is repaired, etc., there is a chance that the leads will be reversed when it is hooked up again. This is why it is important to run a simple test every time to verify the fact that the current is flowing in the right direction.

The accompanying drawing shows the correct way to hook up the unit, and also a means of verifying the direction of current. Note that the pipe line must be connected to the negative terminal of the rectifier and the ground bed to the positive side. As a check, use two screwdrivers, or steel pins, and a volt meter of not less than 5,000 ohms per volt sensitivity. Place pin A near the pipe and A′ about 25 to 50 feet away in the direction of the ground bed, and observe the polarity between them. Check at B and B′ in the same manner. Voltage will be higher between B and B′ than between A and A′ as a rule. The direction of the current through the soil will be shown by the voltmeter in each instance.



Portable Valve Operator Eases Pipeliner's Work

Take a look at the design of our many one-man stations and you'll find that most of the valves are equipped with operators—electric or pneumatic—for push-button control. But what of the remainder of the valves? In many instances they pose quite a problem.

For example, one company that has a number of such stations, found that the pipeliner who looked after it, had to open and close 4 large gate valves on the strainer traps each week. The hand operation involved required 36 turns of a 20-inch hand wheel to open or close each valve. Multiply this by 8 and add in a few other valves, and you have an exerting day's work.

But out of exertion come labor saving devices. One of these lonely pipeliners eliminated most of the work and gained more time for fishing and hunting by devising an electric valve operator. (Moreover his company rewarded him with a sizable check for his venture into mind over matter.)

The drawing shown here tells most of the story. The reversible motor drive is similar to those found on power timber saws and the pipe spool is sized to fit inside any of the hand wheels of large valves at the station. The electric cable that runs to the 110 volt power source has a ground wire for safety reasons.

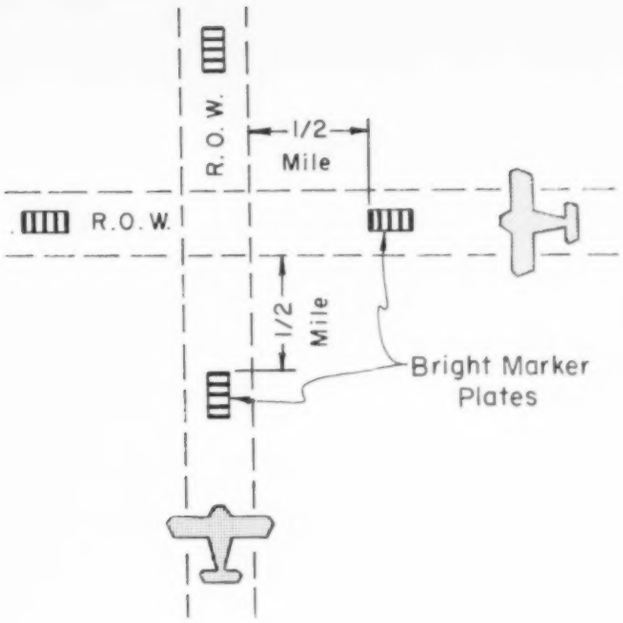
The cost of this device ran about $100.

Magnetic Strip Holds Instruments in Place

Every drafstman ought to have one. It can save his back, his lungs and his temper. For it will enable him to put more tilt on his board cutting down on the degree of humping over his work.

The only reason most draftsmen don't use more tilt is that the cover paper is slick and anything in the way of instruments, etc., laid on it tends to end up on the floor.

But this small magnetic strip with a rubber grip bottom can help a great deal. Instruments will cling to it, and it clings to the paper. In addition to holding the compasses, etc., it will prevent triangles and French curves from sliding onto the floor. The cost—negligible.



Markers Could Prevent Patrol Plane Collisions

Brightly colored plates one-half mile on either side of foreign pipe line crossings will serve to warn the pilot that other patrol planes may cross his line of flight.

There are many patrol planes flying in good weather, and for the most part the pilot's attention is focused on the pipe line right-of-way. Because the planes fly at similar altitudes there is danger of mid-air collisions at the intersections of the lines.

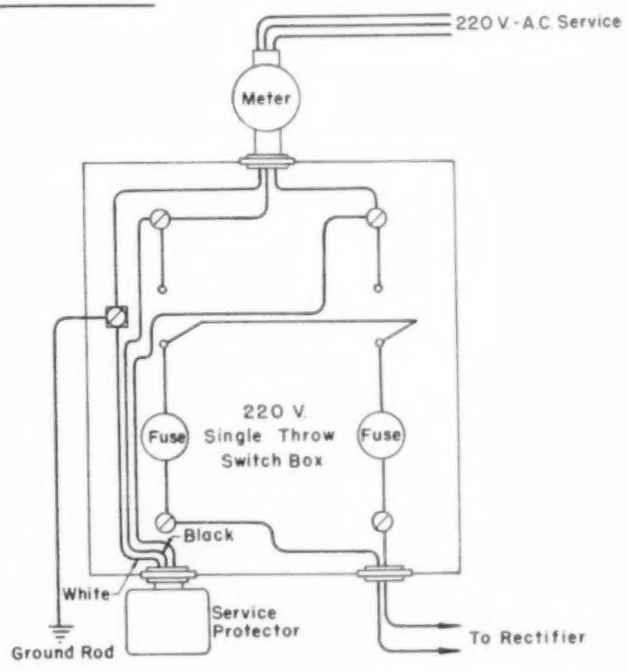
The marker can be small—12 x 18 inches will do—and it should be striped with bright colors. It should be mounted on a small concrete slab to elevate it slightly above the right-of-way.

Use Lightning Arrestors In Protecting Rectifiers

Here is an inexpensive means of protecting rectifiers against lightning and heavy power line surges. Cost of this protection per unit runs about $5.50; and savings could run many times this amount should lightning strike in the vicinity.

By installing a pellet-type service protector rated at 175 volts A.C. at the switch box ahead of the rectifier, and wiring it as shown here, damage from severe overloads can be eliminated. The service protector shunts the current to ground instantaneously when a heavy surge starts, acting much faster than conventional fuses, and breakers.

Aside from saving the cost of equipment, the service protector may keep the protection system from being out of service while repairs are being made.



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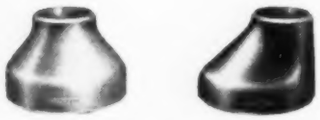

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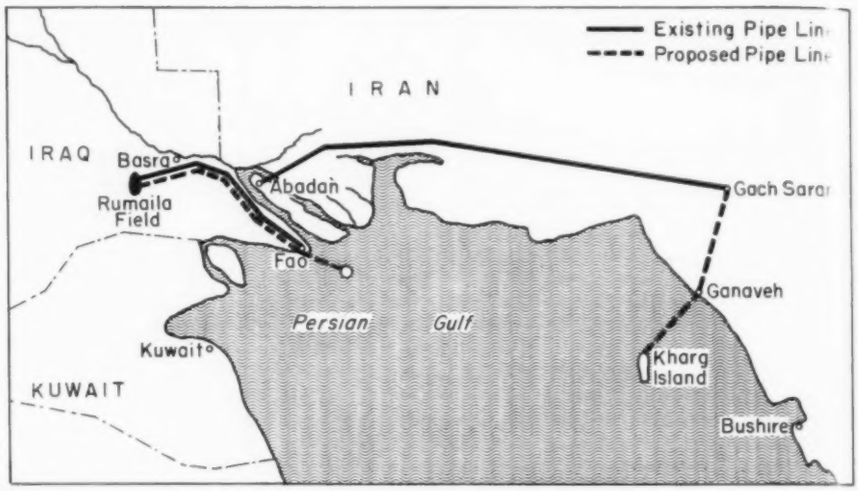
WHAT'S HAPPENING IN PIPE LINE CONSTRUCTION

By Donald G. DePugh, Construction Editor



Contracts Let on Two Submarine Crude Lines in the Persian Gulf

Two major outlets for oil in the Persian Gulf will be made possible with completion of Iran's 100-mile, 26-30-inch line from Gash Saran and Iraq's 110-mile, 30-32-inch line from Rumaila Field.

Iranian Oil Exploration and Producing Co., has awarded contracts on its $56 million project which includes a 72-mile, 26- and 28-inch line to the Persian Gulf at Ganaveh and a 25-mile, 30-inch submarine line to Kharg Island.

The undersea line will be constructed by Collins Submarine Pipelines Overseas, Ltd.; the inland section will be built by Raymond Concrete Pile Company, U.S.; Williams Brothers Company, U.S.; Werkspoor & Bredero, Holland; Constructors John Brown Ltd., and Richard Costain Ltd., London.

The line will be in operation by 1960 and will raise the Gash Saran output from its present 60,000 barrels to 390,000 barrels daily without pump stations. Capacity can be increased to 450,000 barrels with installation of pump stations. Helicopters are being used for survey work and carrying personnel and urgent parts. The line is part of a $140 million program planned by the Iranian Oil Consortium.

Iraq Petroleum Company and its affiliate, Basrah Petroleum Co., plan a $40 million project consisting of a 30-32-inch loop line paralleling its smaller lines from Rumaila to the Gulf at Fao and twin 32-inch offshore lines extending 25 miles to a planned unloading terminal. Collins Submarine Overseas Pipelines Ltd. has been awarded the contract for the offshore lines.

The new facilities will increase Iraq's daily capacity of the Rumaila and Zubair Fields from 240,000 barrels per day to 440,000 barrels daily.

Contracts for construction of the terminal have been let to Raymond International (U.K.), Ltd., De Long, Ltd., London, and Richard Costain, Ltd. of London.

Michigan Wisconsin Awards Contract on 385 Miles

Michigan Wisconsin Pipe Line Company has awarded contracts on its 385 mile looping project in Kansas, Missouri, Iowa, Illinois and Michigan.

R. H. Fulton & Company will lay 220 miles, 26-inch in Kansas and Missouri. Fulton will construct its portion with six spreads. Panama-Williams Corporation will construct 120 miles, 26-inch, loops in Iowa and Illinois and Somerville Construction Company has 38 miles, 26-inch in Northern Michigan.

Construction of the $32 million project will start April 1 and completion is expected by June 15.

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developed for economical, dependable low pressure piping systems

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Substantial savings realized in purchase price of fittings and pipe.

REDUCED WEIGHT

Important weight reductions achieved by reducing wall thickness to correspond with service requirements.

GREATER FLOW

Larger inside diameter provides increased flow capacity.

EASE OF INSTALLATION

Reduced weight facilitates handling . . . speeds installation.

AVAILABILITY

Stocked in sizes 4" through 24". Wall thicknesses range from .188" to .250".

CONFORMITY TO SPECIFICATIONS

These fittings meet all requirements of ASA Code for Pressure Piping B31.1—1955 and B31.1.8—1955, ASTM A234 and ASA B16.9.

Lower purchase cost . . . reduction in weight . . . economy and ease in installation . . . increase in flow capacity—these are multiple advantages gained in using Ladish Light Weight Seamless Welding Fittings.

These Light Weight Fittings have been developed and produced under rigid metallurgical and manufacturing standards as part of a continuing program to meet the specific needs of industry for economical, functionally designed fittings.

Specification sheets on Light Weight Welding Fittings and Flanges available on request.

L

TO MARK PROGRESS

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The special steel used in Double Gray provides extra resistance to the deforming effects of peening and crushing which occur on the drums and sheaves of heavy equipment. Double Gray also gives extra resistance to abrasion.

Because of these superior qualities, Double Gray rope quickly repays its slightly higher initial cost in safer, more economical operations. Use it wherever extra high strength wire rope is required.

For a free copy of our Double Gray booklet, write to: Advertising Department, The Colorado Fuel and Iron Corporation, 575 Madison Avenue, New York 22, N. Y.

**Wickwire Double Gray Wire Rope is made of extra-improved plow steel. Fortified by an independent wire rope core of the same extra high strength steel, Double Gray rope has a 15% higher breaking strength than the catalog breaking strength of an improved plow steel rope with IWRC.*

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CF&I STEEL

Coastal States Lets Contract On Portion of Gathering System

Coastal States Gas Producing Company has awarded a contract to O. R. Burden Construction Corp., on a portion of its 290-mile gas gathering system in South Texas.

Burden will lay 95 miles of 8-20-inch from a point north of Falfurrias to McAllen. Included are 57 miles, 20-inch main line, 7 miles, 16-inch; 13 miles, 14-inch; 13 miles, 10-inch, and 2 miles, 8-inch.

The complete gathering system will extend from Falfurrias to McAllen to the Webb-LaSalle County area.

Coastal Awards Contract To Oklahoma Contracting Co.

Coastal Transmission Corporation has awarded a contract to Oklahoma Contracting Company for construction of approximately 40 miles of 20-inch pipe line in Matagorda and Jackson Counties, Texas. Coastal is building a 570-mile gas line from south Texas to Baton Rouge, La.

Texas Gas Transmission Application Accepted by FPC

The Federal Power Commission has accepted an application from Texas Gas Transmission Corporation requesting permission to construct a $40 million project.

Included in the application are plans for 165 miles, 30-inch, and 81 miles of 26-inch loops between Eunice, La., and Lebanon, Ohio. One river crossing—a 26-inch line across the Green River between Slaughters and Owensboro, Ky., will be laid. Texas Gas also proposes to construct 102 miles of supply lines in South Louisiana and adjacent offshore areas. Compressor horsepower will be installed at Columbia, La., Covington, Kenton, Tenn., and Calvert City, Slaughters and Hardinsburg, Ky., and Lafayette, La.

Rio Gas Gathering Co. Plans South Texas System

Rio Gas Gathering Company of San Antonio has been formed to build 9[illegible] miles of 3 to 8-inch gas pipe lines in South Texas to sell gas to El Paso Natural Gas Company.

Rio system will tie in with the 136-mile gathering lines planned by Gulf Resources, Inc. (PIPE LINE INDUSTRY, July, Page 60).

In the Centennial Year of the American Petroleum Industry, Transco is investing $100,000,000 in the pipeline system that carries Texas and Louisiana natural gas to the markets where the most people are.
TRANSCONTINENTAL
GAS PIPE LINE CORPORATION

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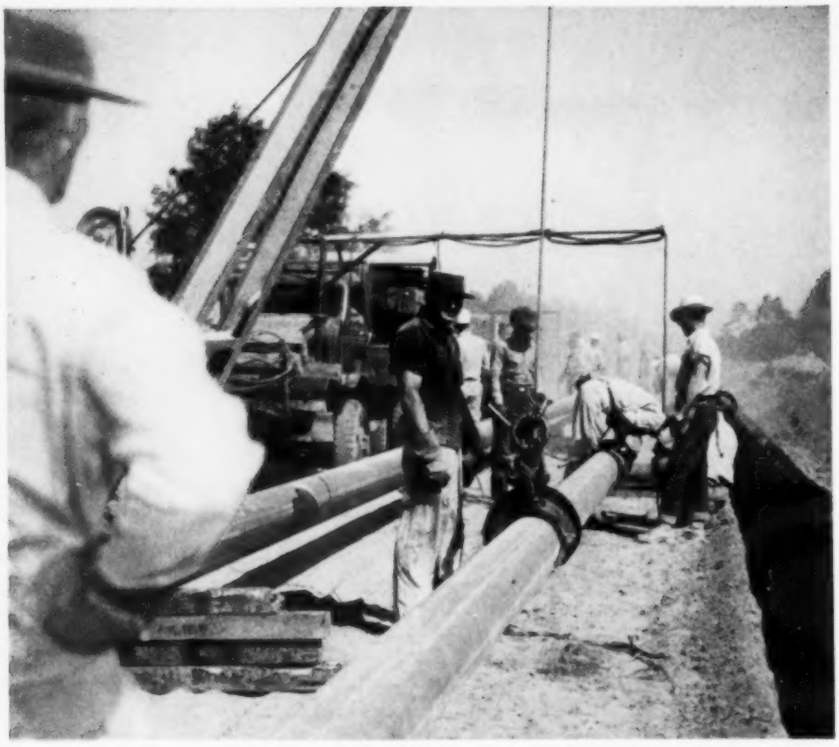

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...quality controlled for long, trouble-free service

Crossing rivers, bending over steep hills and rugged terrain is routine for Lone Star electric weld line pipe. Joe Roughneck, heart of the oil and gas industry, knows he can depend on Lone Star API casing, tubing and line pipe . . from the oil country's own steel plant. Fully normalized, of course.

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Trans-Canada Pipe Lines Plans Station Additions

Trans-Canada Pipe Lines, Ltd., plans to construct four new compressor stations and install 15 sales meter stations at a cost of $15.5 million.

Northern Ontario Pipe Line Crown Corporation will construct three of the stations to be located at Ignace, Geraldton and Hearst, in Northern Ontario. The fourth will be installed by Trans-Canada on its line near Maple, 20 miles north of Toronto.

Trans-Canada was granted permission to export 1.1 trillion cubic feet of gas in addition to the 4.35 trillion already certified. Future expansion plans for the pipe line company include construction of 500 miles of loops to be completed by 1962. Compressor station facilities will be increased from 65,000 horsepower to 304,500 horsepower by the end of 1959.

Texas Eastern Awards O. R. Burden Contract

Texas Eastern Transmission Corporation has awarded a contract to O. R. Burden Construction Corporation to lay 68 miles of 8-inch products line from Carthage to Tyler, Texas.

The line will join Texas Eastern's Little Big Inch system at Carthage and the La Gloria Oil & Gas Company refinery at Tyler. Brown and Root, Inc. will install a 500-horsepower pump station at Tyler.

Interprovincial Pipe Line Plans Station Additions

Interprovincial Pipe Line Company has announced plans to install a new pump station at Iron River, Mich., and to add to existing pumping facilities at Edmonton, Alta.

An automatically controlled electrically driven pump station with 6,150 horsepower, will be constructed at Iron River as part of the Lakehead Pipe Line Company system. Lakehead is a wholly owned subsidiary of Interprovincial. A 4,450-horsepower electrically driven station will be housed in an extension of the present building at Edmonton.

Capacity of the Interprovincial-Lakehead system will be increased to 290,000 barrels at Edmonton, 365,000 barrels daily at Cromer, Manitoba, and 300,000 barrels daily at Superior.

Northern Oklahoma Lets Contract on 70 Miles

O. R. Burden Construction Corporation will build 58 miles of 12-inch and 12 miles of 10-inch for Northern Oklahoma Gas Co.

The $2.5 million line extends from Cherokee to Ponca City, Okla. Gas will come from the Grant and Alfalfa County fields in northern Oklahoma.

Buckeye Awards Contract to Sheehan on 11-Mile Line

Buckeye Pipe Line Company has awarded a contract to Sheehan Pipe Line Construction Company to build an 11-mile, 6-inch line to carry jet fuel to the Griffiss Air Force Base at Rome, N. Y.

The lateral line extends from a point on Buckeye's recently completed Syracuse-Utica, N. Y. line to the air base. The $1.3 million project includes tankage and pumping facilities.

Northern Natural Files Applications With FPC

Northern Natural Gas Company has filed two applications with the Federal Power Commission requesting permission to construct 438 miles of main line extensions and loop lines and 1,906 miles of branch lines.

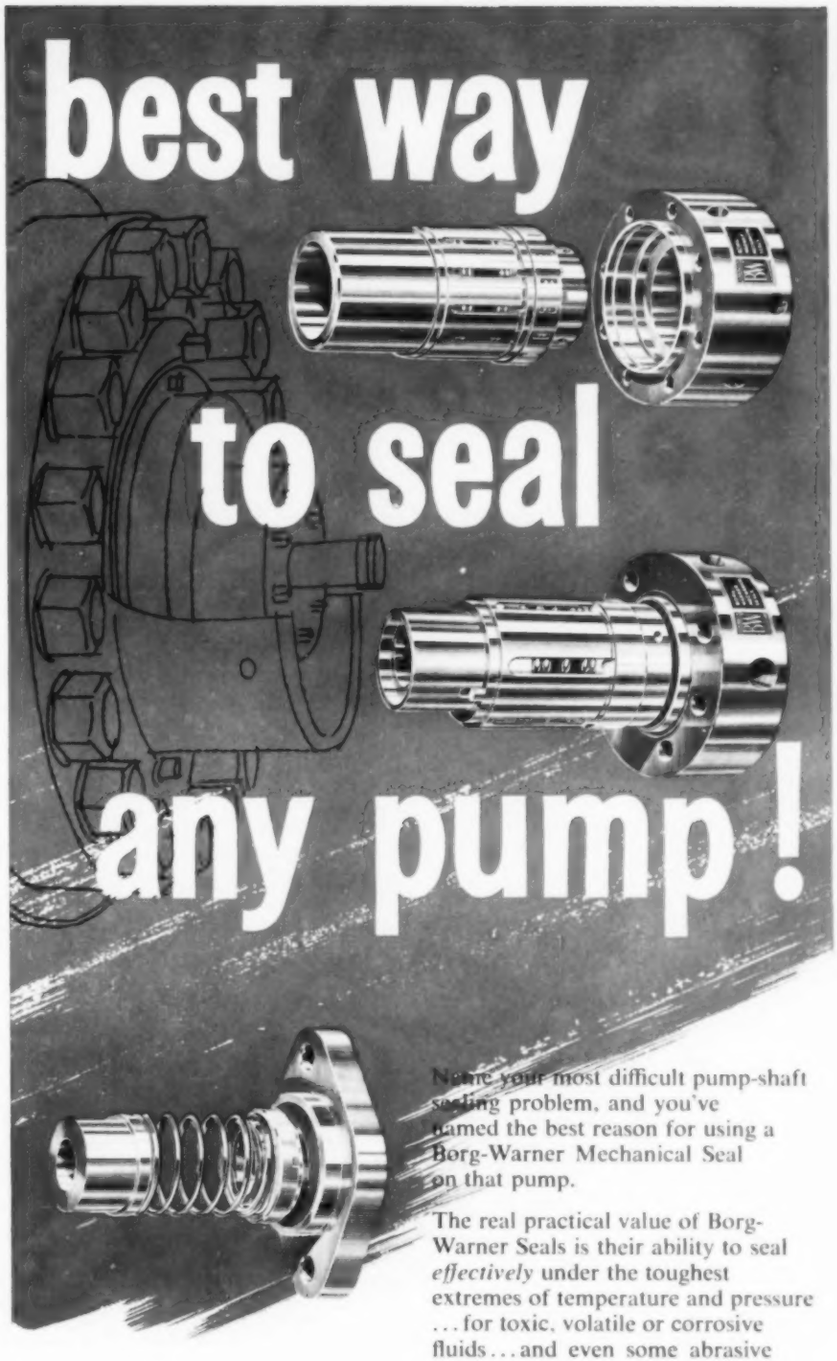
The $100 million project will enable Northern Natural to serve an additional 326 communities in six states. The expansion program will extend over a period of 3 years and will boost Northern's capacity 217 Mmcf of gas per day.

Construction Progresses On Kuwait Oil Co. Line

Construction has passed the halfway mark on an 80-mile, 30-inch crude oil line being built by the Kuwait Oil Company from the Raudhatain field to a new terminal in northern Kuwait.

Lone Star Gas Company Plans $30 Million Program

Lone Star Gas Company has announced plans for a $30 million construction program for 1959. Included in proposals will be over $25 million for new facilities and about $5 million in expanding existing facilities.



Name your most difficult pump-shaft sealing problem, and you've named the best reason for using a Borg-Warner Mechanical Seal on that pump.

The real practical value of Borg-Warner Seals is their ability to seal *effectively* under the toughest extremes of temperature and pressure ... for toxic, volatile or corrosive fluids ... and even some abrasive liquids. *Result* – less down time, elimination of expensive stuffingbox maintenance, and savings of the pumped fluid.

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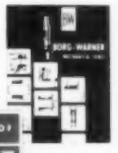

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PROPOSED PIPE LINE CONSTRUCTION

Here in convenient summary form is Pipe Line Industry's listing of company, line size, length, service, location and project status.

U. S.

Alaska Juneau Gold Mining Co., Los Angeles, 425 miles, 16-inch, gas, Oklahoma City area to St. Louis, planned.

Arkansas Industrial Pipeline Corp., Shreveport, 130 miles, 18-inch, gas, Perla-to-Helena, Ark., $9 million, planned.

Arkansas Louisiana Gas Co., Shreveport, 100 miles, 16-inch, gas, from near Clarksville-to-Jones Mill, between Malvern and Hot Springs, Ark., $6 million, construction underway, by Arkansas Louisiana Gas Co.

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3492 W. Hospital Ave., Chamblee, Ga. — Atlanta Phone: GLendale 7-2368

*Negotiations and inquiries strictly confidential.

Buckeye Pipe Line Company, New York, 70 miles, 8-inch, products, from Wayne to Flint, Michigan, planned.

11 miles, 6-inch, jet fuel line, point on Syracuse-Utica line to Griffiss Air Force Base, $1.3 million, contract let to Sheehan Pipe Line Construction Company.

Chicago District Pipeline Company, 2 miles, 30-36 inch, gas, from Natural Gas' proposed line at Joliet to Chicago, $3 million, before FPC.

Cities Service Gas Company, Oklahoma City, 106 miles, gas, gathering, in Montgomery, Allen, Franklin, Miami, Johnson, and Wilson counties, Kansas, 3,600 hp to Blackwell station, Kay County, Kansas, FPC authorization.

Coastal States Gas Producing Co., Corpus Christi, Texas, 289 miles, 14 and 16-inch main line and gathering system, McAllen to Falfurrias, Tex., area, and Lopena to La Salle County, $12 million, contract let on 95 miles to O. R. Burden Construction Corp.

Coastal Transmission Corp., Houston, 514 miles, 22-24 inch, gas, from McAllen, Texas to Baton Rouge, La. connection of Houston, Texas Gas and Oil plus 414 miles of laterals, $55 million, contracts let on compressor stations to Gasoline Plant Construction Corp. Contract let on main and laterals, to Oklahoma Contracting Co., and O. R. Burden Construction Corp., River Construction Corporation, Parson Company, Brown & Root, Buddy Sherrod, Inc.

Colorado Interstate Gas Co., Colorado Springs, 140 miles, gas, Green River, Wyo.-to-Provo, Utah; 109 miles, 26-inch, Texas Panhandle to southeastern Colorado; 136 miles, 34-inch, southeastern Colorado-to-Pueblo, Colo.; 107 miles, 30-inch, Pueblo-to-Denver, $91 million, before FPC.

Consumers Power Co., 45 miles, gas, main line, from Woodbury station to Laingsburg Junction, Mich., planned.

126-miles, 26-inch, gas, main, Michigan-Indiana border to Plymouth, Mich., planned.

El Paso Natural Gas Company, El Paso, 216 miles, 26 to 34-inch main line, 533 miles, 6-20-inch laterals, gas, 86,750 compressor hp; 126 miles, 30-inch main line, 266 miles, laterals, gas, 28,920 compressor hp in new and existing stations in Arizona, New Mexico and Texas, contracts let on 819 miles to R. H. Fulton & Co., McVean & Barlow, Inc., Western Pipe Line, Inc., Eastern Pipeline Contractors, and Engineers Limited Pipeline Co.

400 miles, 34-inch, Salt Lake City, Utah, to California border, planned.

Equitable Gas Company, Pittsburgh, Penn., 11.7 miles of storage pipe line and other facilities, $2,091,430, authorized.

Everglades Pipe Line Company, Miami, Fla., 35 miles, 10-inch, products, Port Everglades to Miami International Airport, $2.5 million, contract let to Latex Construction Co.

Gillette Pipeline Co., Cheyenne, Wyo., 103 miles, crude, from Dead Horse Creek field to Casper, Wyo., planned.

Great Northern Railway, St. Paul, 400-600 miles, 12-20 inch, crude, from Williston Basin to St. Paul-Minneapolis and Duluth-Superior areas, considered.

The CLEVELAND 240 TRENCHER

12′ x 2½′ V CONVEYOR

- **Power-Shifted**
- **Power-Folded**

controlled from operator's seat

WORLD'S FINEST TRENCHER CRAWLER

For 20″ dia. pipe 240 here digs trench to average 4′ deep, 34″ wide at bottom, sloped to approx. 5′ wide at top.

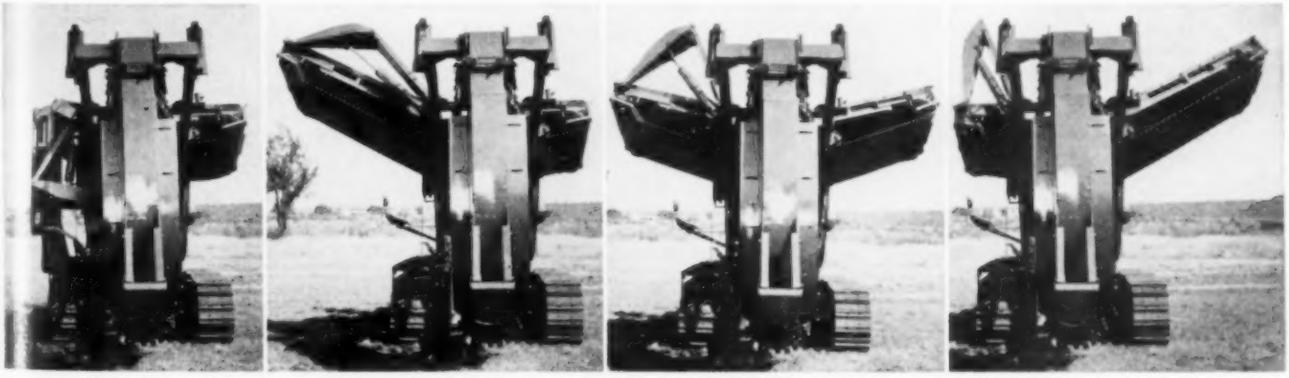
DIGS FULL 3′ WIDE by 6′3″ DEEP

V CONVEYOR... provides maximum clearance under digging wheel rims... allows higher heaped loads without clogging... provides constant elevating angle for faster, higher spoil discharge... reduces rolling and tumbling... has stronger, torsion-free construction... employs huskier, longer-lived bearings.

POWER-SHIFT... operator controls hydraulic shifting and positioning of conveyor... digs past poles, trees, fences... places spoil where needed... all without leaving seat, without interrupting other operations.

POWER-FOLD... brings conveyor's 12-foot length down to within trencher's overall 8-foot width... permits transport without special highway permits... same automatic system unfolds conveyor to digging position.

FINEST CRAWLER on any trencher... double flanged wheels, rollers and sprockets with wide spaced teeth... drives on each end of 1½″ dia. hardened pins... completely eliminates pockets for dirt, stones, etc.... gives greater track stability ... lengthens wear life... sprockets, wheels and idlers ride on sealed ball or roller bearings requiring only 200-hour lubrication... has big 16″ x 3″ hydraulic steering brakes... a tremendously long-lived, trouble-free, easy-rolling crawler track.



Power-folded | Power-shifted, left | Centered V Conveyor | Power-shifted, right

Good Everywhere ®

The CLEVELAND TRENCHER Co.

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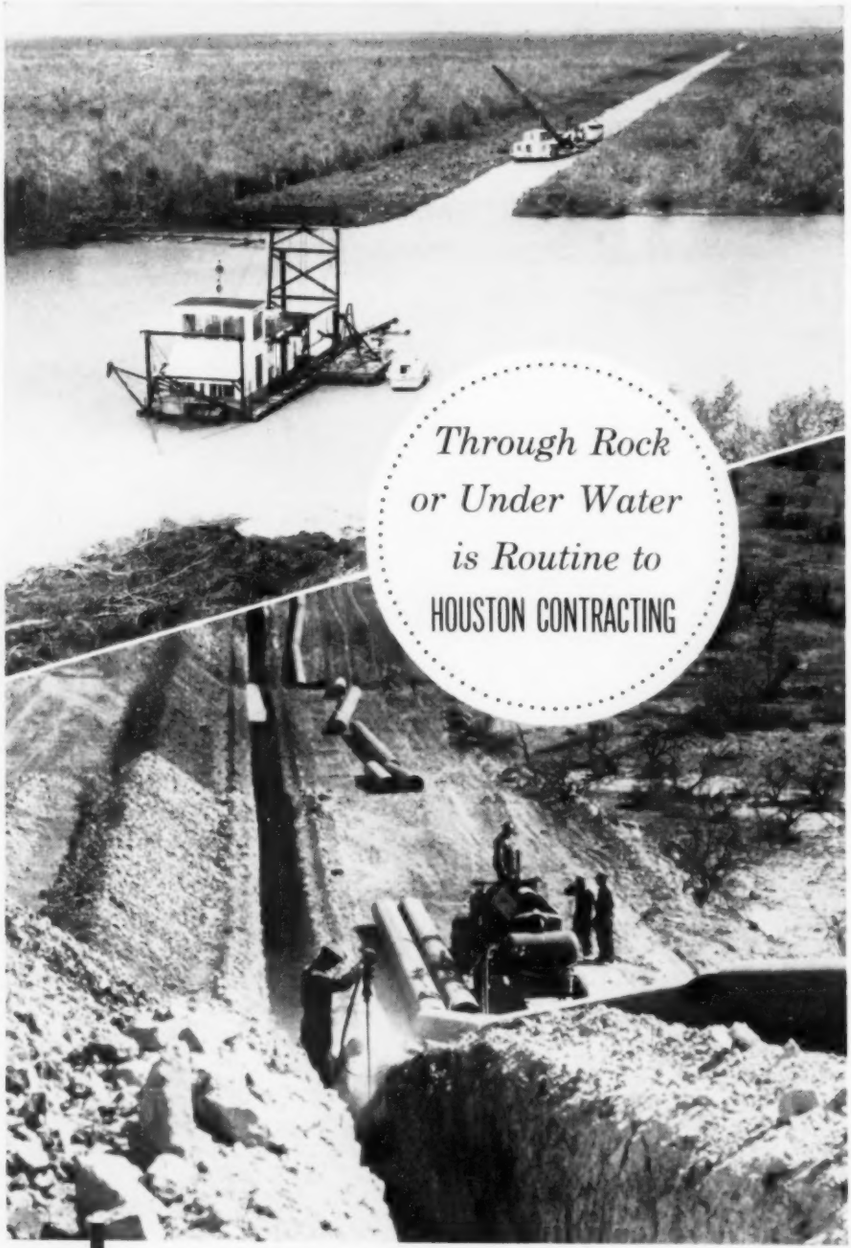

Well known for their unexcelled experience in the marshlands, Houston Contracting is equally adept at handling the problems encountered in all types of terrain. Swamp gumbo, rock, sand, and frozen ground, all have given way to Houston. If it's pipelining, Houston Contracting can do it efficiently and on schedule.

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OIL • GAS • PRODUCTS • WATER PIPELINES

Columbia Gulf Transmission Co., Houston, 12.8 miles, 6 and 20-inch, gas, loop line in Louisiana, $730,000, authorized.

Gulf Pacific Pipe Line Company, 1,600 miles, 30-inch, gas, Louisiana to California border, considered.

Gulf Resources, New York, 125 miles, gas, gathering system, from Lopena area in Zapata County to a point in La Salle County, Texas, planned.

Humble Oil & Refining Company, Houston, 116 miles, gas, gathering various sizes, southwest Texas, planned.

Iron Ranges Natural Gas Co., 115 miles, gas, from Itasca and St. Louis counties along route of Mesabi range from Grand Rapids to Aurora, Minn., $5 million, before FPC.

Katy and New York Central Railroads, 2500-mile, 10-12 inch, LPG, from Houston, Texas, to New York, considered.

Manufacturers Light and Heat Co., Pittsburgh, Penn., 21-miles, gas facilities in Pennsylvania and West Virginia, $1 million authorized.

34-miles, 20-inch, in Greene, Adams, and York counties, Penn., authorized.

Michigan Wisconsin Pipe Line Co., Detroit, 385 miles, gas, 14,280 additional hp, $32 million, contract let to R. H. Fulton, Panama, Williams and Somerville Construction Co.

Midwestern Gas Transmission Co., Houston, 350 miles, 30-inch, gas, Portland, Tenn. to Joliet, Ill., $50.8 million, before FPC.

New York State Natural Gas Co., Pittsburgh, 30 miles, 20-inch, gas, main, Silver Springs to East Elma, N. Y., $1.6 million, temporary FPC authorization.

43 miles, 20-inch, point west of Kittanning to Luthersburg, Penn, 14 miles, 26-inch, Little Marsh in Chatham Township to Boom station near Lawrenceville, Penn., and additional horsepower at Woodhull, Utica, N. Y., and Preston and Tonkin, Penn., planned.

Northern Illinois Gas Company, 140 miles, 24-inch, gas, main line, East Dubuque to Des Plaines, Ill., planned.

Northern Natural Gas Co., Omaha, 167 miles, 20 inch, gas, from Farmington, Minn. to Duluth, Minn., and Superior, Wis., $12 million, before FPC.

42 miles, 10 inch, gas, from Rochester, Minn. to Winona and Goodview, Minn., $963,000, before FPC.

365 miles, gas, new facilities in Minn., Iowa, S. D., Neb., Wis., plus 1090 miles of branch line and station facilities, $65.7 million, authorization for a part. Gas facilities in Texas, Oklahoma and Kansas, $6 million, before FPC.

454 miles, main line loops and extensions, 6-30-inch, main line from St. Cloud, Minn., to Grand Forks, N. Dak., also 1,490 miles of branch lines, 2-10-inch, and station additions totaling 32,000 horsepower, $86 million, before FPC.

27.6 miles, 30-inch, gas, loop; 18.3 miles north of Beaver station in Okla., 9.3 miles north of Sunray station in Texas, $3 million, authorized.

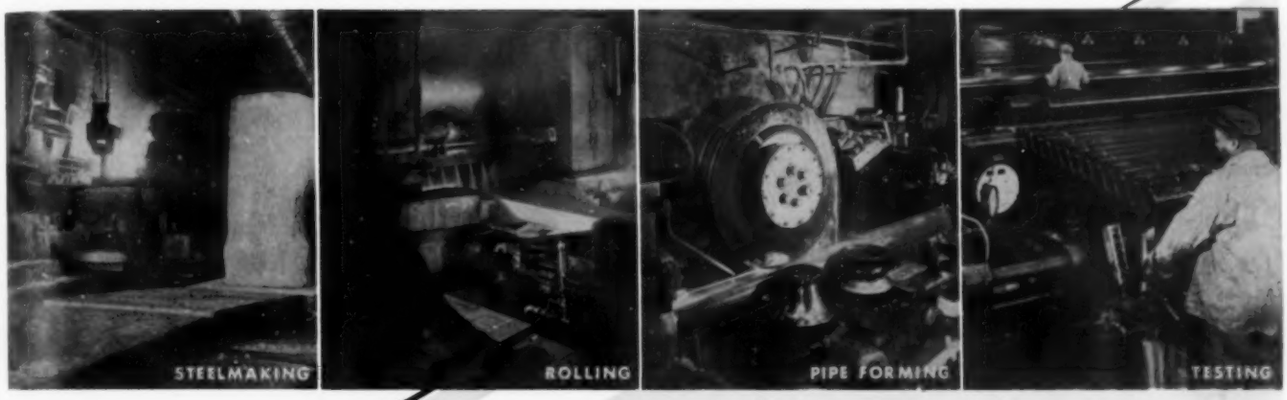
Northern Utilities Co., 35 miles, 16 inch, gas, in Fremont Natrona County, Wyo., area; 8 miles, 12 inch, around Casper; 6 miles, 8 inch, from Sand Draw gas field to Beaver Creek field; 12 miles, 6

For more data on advertised products, use Readers' Service Cards, last page.

Acme-Newport

ELECTRIC WELD LINE PIPE*

QUALITY CONTROLLED THROUGH EVERY STAGE OF PRODUCTION



The outstanding on-the-job performance of Acme-Newport line pipe is a direct result of control throughout all processing operations. This basic steel producer melts all line pipe steel exclusively in electric furnaces, widely recognized for their high degree of metallurgical accuracy. Comparable exactness continues in each succeeding operation . . . in rolling, skelp preparation, pipe forming, annealing, sizing and final testing. The result is a product of inherent strength and uniformity.

A true round pipe that bends readily, welds easily, installs and functions trouble-free. Let us demonstrate our ability to meet your requirements.

Acme-Newport Steel COMPANY

NEWPORT, KENTUCKY

A SUBSIDIARY OF ACME STEEL COMPANY

***SIZES AND WEIGHTS AVAILABLE**

O.D.	Wall	Wt. Per Ft.
4½	.125"	5.84
	.142"	6.61
	.156"	7.25
	.188"	8.64
	.219"	10.00
	.237"	10.79
6⅝	.156"	10.78
	.188"	12.89
	.219"	14.97
	.250"	17.02
	.280"	18.97

ECONOMICAL WATERAIL-TRUCK DELIVERY

Newport Steel is situated on the Mississippi-Ohio River system and the great Cincinnati rail hub. With the advantage of location, new river barge facilities and seven major railroads, Newport gives economical, dependable delivery to industrial areas throughout the Middle West and South.

inch, from Beaver Creek field to the system servicing the Riverton-Lander area, planned.

Northern Oklahoma Gas Co., 70 miles, 10-12-inch, gas, main, Grant and Alfalfa counties to Ponca City, Okla., contract let to O. R. Burden Corp.

Ohio Fuel Gas Co., 51 miles, gas, main lines, in Belmont, Carroll, Cuyahoga, Fairfield, Logan, Lorain, Marion, Muskingun, Stark and Wayne counties, Ohio, $2.2 million, authorized.

Natural gas storage field in Medina County, Ohio, 12 miles, 4½ to 20-inch gas, $5 million, authorized.

Pacific Gas & Electric Co., San Francisco, 296 miles, 36-inch, gas, from Klamath Falls, Ore., to Antioch, Calif., southern section of line from Canada to California, before California Public Utilities Commission.

Pacific Gas Transmission Co., San Francisco, 614 miles, 36-inch, Kingsgate B.C. to Klamath, Ore., northern section of Canada to California line, before FPC.

Pacific Lighting Gas Supply Co., 128-mile, 34-inch, gas, main line from Topock, Ariz. to Newberry, Calif., authorized.

Pacific Northwest Pipeline Corp., Salt Lake City, 235 miles gas, gathering lines in San Juan Basin, Garnesa, Piceance Creek, and Big Piney Fields, $13.5 million, planned.

65 miles, gas, sales laterals in Washington, $1.5 million, planned.

Pennsylvania Gas Co., Warren, Penn., 38 miles, 8 and 10 inch, gas, in Erie and Warren Counties, Penn., and Chautauqua County, N. Y., $2.6 million, authorized.

Piedmont Gas Co., Hickory, N. C., 78 miles, 2-8 inch, gas, from connection with Transcontinental Gas Pipe Line to serve customers in North Carolina, $1.6 million, authorized.

Pioneer Natural Gas Co., Amarillo, Texas, 62 miles, 10-inch main, Pampa, Texas, to Canyon, in Randall County, Texas, 20 miles, small diameter, gathering, 4,000 h.p. stations, $4.5 million, planned.

Phillips Petroleum Co., 25 miles, 6 to 10-inch, gas, South Eunice, New Mexico area, planned.

52 miles, 4 to 20-inch, gas, Gaines County, Texas, planned.

44-mile, 6-inch, products line, from Rocky pump stations to Amarillo, Texas, planned.

Rio Gas Gathering Co., San Antonio, 37 miles, 3 to 8-inch, gas gathering, South Texas, to supply gas to El Paso Natural Gas Company, planned.

Southern California and Southern Counties Gas Cos., Los Angeles, 200 miles, 34-inch, from Nevada-California border to point near Fullerton, Calif., $44 million, before Public Utilities Commission.

Southern Kansas Pipe Line Co., Inc., Arkansas City, Kansas, 200 miles, 6-10 inch, crude, southwestern Kansas to Arkansas City, Kansas, planned.

Southern Natural Gas Company, Birmingham, 136 miles, 24 and 26 inch; 215 miles, various diameter supply lines; 3,650 additional compressor horsepower to White Castle and Toca Stations; 8 miles, 20-inch loops; 660 hp Franklinton station, and 23 measuring stations. $40 million, contracts let to William Brothers, Western Pipe Line, Inc., Brown & Root, Inc., and River Construction Corp. on 305 miles.

458 miles, 16-24-inch, loop lines, gas, between Gwinville, Miss., and Wrens, Ga.; 62 miles, 14-inch, loops, along Atlanta-Macon line; 53 miles, 6⅝ to 14-inch, loops, along various branch lines. 3,140 additional hp at Gallion and Elmore, Ala. and Wrens, Ga. 60 miles, 20-inch, loops, in Louisiana between Franklinton and White Castle and South of Toca. Lateral lines south of Gwinville and west to Cranfield field. 8,720 hp added at Franklinton, White Castle, Patterson and Brookhaven, $65 million, contracts let to River Construction Corp., H. C. Price, Latex Construction Co., and Houston Contracting Co. on 355 miles.

Tennessee Gas Transmission Co., Houston, 21 miles, 16-inch, 2 miles, 12¾-inch, gas, Louisiana coast, Vermillion, Blocks 46 and 64, $2.9 million, before FPC.

158 miles, 36-inch, looping system in Louisiana and Mississippi, to supply Midwestern additional gas at Portland, Tenn. $61.4 million, before FPC.

Texas Eastern-Penn-Jersey Transmission Corp., Shreveport, La., 65 miles, gas, from Delmont, Penn., to Lambertville, N. J., before FPC.

24,000 compressor hp additions to existing stations, $4.4 million, temporary FPC authorization.

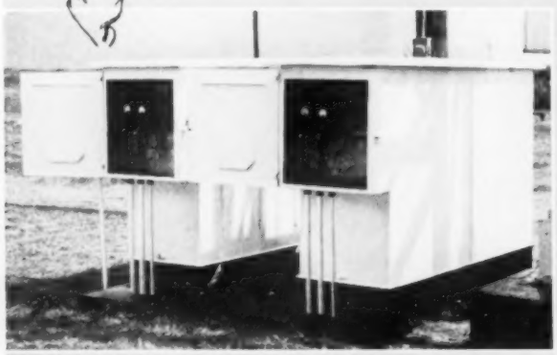
4,000 horsepower to its Delmont, Penn., compressor station, five new compressor stations in Pennsylvania with total capacity of 67,000 hp, $11.2 million, authorized.

Texas Eastern Transmission Corp., Shreveport, La., 267 miles, 14-30 inch, gas,

STOP CORROSION WITH B-K CATHODIC PROTECTION EQUIPMENT

CHECK THESE B-K RECTIFIER ADVANTAGES:

- Selenium stacks or Silicon Diodes derated for climatic conditions
- Heavy duty transformer
- All-welded, heavy-gauge steel case—double hot dipped galvanized
- Weston Type 506 D. C. Voltmeters & Ammeters, or equivalent



B-K Recifiers are Custom Engineered

COMPLETE CATHODIC PROTECTION EQUIPMENT — BK

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BEAUMONT, 1050 RAILROAD, PH. TE 3-2679

Louisiana, Mississippi, Pennsylvania and New Jersey, $50 million, before FPC.

96.5 miles, 30-inch, gas, between Kosciusko, Miss., and Uniontown, Penn.; 4 miles of supply laterals; a 10,250 hp compressor station, and 33,360 hp to existing compressor stations, $24.5 million, authorized.

141,780 additional horsepower in existing stations, a new 2,200 hp compressor station, in Louisiana, Mississippi, Pennsylvania, Ohio, Kentucky and Tennessee, authorized.

10 miles, 8-inch, LPG, Lebanon to Todhunter underground storage in Ohio, 62 miles, 8-inch, Tyler to Carthage, Texas, contract let to O. R. Burden Construction Corp.

Texas Gas Gathering Corp., Shreveport, 36.6 miles, gas, gathering system in Rodney Field, Jefferson County, Miss. and from North and South Locust Ridge, Lake St. John Field in Tensas and Concordia parishes, La., $855,413, before FPC.

Texas Gas Transmission Corporation, Owensboro, Ky., 92 miles, 30-inch, 19 miles, 26-inch, and 15 miles, small diameter, loop portions of system in Louisiana, Arkansas, Mississippi, Kentucky, Indiana and Illinois; additional horsepower at Pineville, La., Kenton, Tenn., Calvert City, Ky., Slaughters, Ky., Dillsboro, Ind., and Petersburg, Ind., totaling 9,040 hp. $20 million, contract let on 30 miles to Houston Contracting Co.

246 miles, 26-30-inch, loops, between Eunice, La., and Lebanon, Ohio, 102 miles, supply lines, south Louisiana, and addition of 15,760 hp, $40 million, before FPC.

Texas Illinois Gas Pipeline Company, Chicago, 16,000 additional hp to stations at Lufkin, and Marshall, Texas; Texarkana, Malvern, Searcy, and Biggers, Ark.; Jackson, Mo.; and Hammond, Ill., $3.9 million, before FPC.

Transcontinental Gas Pipe Line Corp., Houston, 204 miles, 36-inch, 107 miles, 30-inch, main line loops in 10 states; 3 intermediate stations: North Carolina, Virginia, Pennsylvania; 2,500 additional hp at six compressor stations; 164 miles, 24-inch from Leidy storage Penn.; 29 miles, 30-inch, New Jersey; gathering lines, Louisiana, 119 miles; 10 meter stations; additions to West Cameron and High Island area, 35-miles, 16-inch, 26 miles, 10-inch, and three gathering meter stations; 45 miles, 16-inch, purchase laterals and 5 meter stations, Louisiana; 67 miles, 10, 12, 20-inch miscellaneous transmission purchase laterals in Texas and Louisiana, 3 meter stations; 51 miles, 36-inch and 1 mile, 30-inch in New Jersey; 51 miles, 10- and 14-inch and 3 meter stations, southeast Louisiana (mainly offshore), $137.3 million. Contracts let on 710 miles to Bechtel Corp., Sharman, Allen, Gay & Taylor, Panama Williams, J. P. Neill, H. C. Price, Brown & Root, Hallmac Construction Co. and Glaser Construction Company.

151 miles, 24-inch, 12 meter stations, southeast Louisiana, $14.5, authorized.

2,500 additional hp at four compressor stations, St. Francisville, La.; Laurel, Miss.; Linden, Ala. and Wadley, Ala., $3 million, authorized.

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The most dependable, most thoroughly proven engine available today for pumping service. The rugged, simple Fairbanks-Morse "ZC" is known the world over for its rock-bottom economy—its ease of starting in coldest weather—its efficiency on both gas and gasoline, with full-power switch-over to either. Clutch and sheave mount on either end of crankshaft for maximum adaptability. Six "ZC" sizes range from 3 to 30 horsepower.

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A completely guarded squirrel-cage induction motor with exclusive design for oil field service. Heavy-duty protected frame prevents entry of dripping liquids, flying chips or falling particles. Available with high torque, normal starting current—high slip, high starting torque—or general purpose normal torque. Ratings from ½ to 40 hp., 3600 to 600 rpm.

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GENERATORS • SCALES • MAGNETOS • HOME WATER SYSTEMS

For more data on advertised products, use Readers' Service Cards, last page.

Wells, pipe lines, measuring equipment, stations at Leidy storage in Pennsylvania, $12.5 million, authorized.

149 miles, 36-inch, main loops, 34 miles, 20, 24-inch gathering, compressor stations at Neuces County, Texas and St. Helena Parish, La., additional hp in eight stations, $51 million, before FPC.

Trans-Utah Pipeline, 120 miles, 16-inch, gas main line from Uinta Basin to Salt Lake City, considered.

Transwestern Pipeline Company, Houston, 1,305 miles, 24- and 30-inch, gas, main line, from West Texas and Oklahoma-Texas Panhandle area to Topock, Ariz., $193 million, before FPC.

Trunkline Gas Company, Houston, 204 miles, 26-inch, gas, main line from Tuscola, Ill., to Michigan-Indiana border; 464 miles, 30-inch loops between Longville, La., and Tuscola and 45 miles, 24-inch, in Texas, 183 miles gathering, Louisiana, 3000 additional hp at Longville station, $81.5 million, before FPC.

Underground Storage & Exploration. Upper Darby, Penn., 394 miles, 12-inch LPG, from Moundsville, W. Va. to Newark, N. J., $9 million, approved.

95 miles, 6-8 inch, laterals to Mauch Chunk, Penn., and to Philadelphia, planned.

United Gas Pipe Line Co., Shreveport, La., 203 miles, 30-inch, gas, between New Orleans and Mobile, Ala., $33.7 million, contracts let on 30-miles to O. R. Burden, 38 miles to Williams Bros., 12 miles to Western Pipe Line, Inc., and 30 miles to Hallmac Construction Co.

Valley Gas Transmission, Inc., Houston, 160 miles, 3 to 8-inch, gas, gathering, in Hidalgo, Brooks, Starr and Jim Wells Counties, Texas, $15 million, before FPC.

International

ACT Oils, Ltd., Montreal, 400 miles, crude, Dawson Creek, B. C., to Bella Coola, B. C., before B. C. government.

Alaska-Yukon Refiners and Distributors, Ltd., Edmonton, Alta., 150 miles, products, serving Alaska and Yukon territory, $3.5 million, planned.

Alberta Natural Gas Company (Jointly owned by Westcoast Transmission Co. and Alberta & Southern Gas Co. Ltd.) 36-inch, gas, Alberta border to British Columbia-Idaho border, supply gas to Pacific Gas & Electric Co., $40 million, planned.

Bituminous Oil Pipeline Co., Calgary, 150 miles, crude, from Athabasca tar sand plant in northeastern Alberta to Edmonton, approved.

Burmah Oil Co., Ltd., 850 miles, crude, 20 inch, from Nahorkatiya to Calcutta, India, planned.

Cartier Gas Corp. (St. Maurice Gas, Inc., and Consumers Gas Co., Toronto), 170 miles, gas, Montreal to Quebec City, planned.

Colombian Petroleum Company, 68 miles, 12-inch, crude, Cicuco field to Covenas, planned.

Consolidated Gathering Systems, Ltd., Calgary, 198 miles, crude, Sturgeon field to Edmonton, planned.

Development and Resources Corp., 70 miles, 8 inch, gas, from Agha Jari oil field to Ahwaz, Iran, planned.

Entre Nazionali Idrocarburi, Rome, Italy, crude, from Qum field in Iran to the Mediterranean Sea, considered.

Foothills Pipe Line, Ltd., 500 miles, 12 to 16-inch, LPG, from Alberta to Pacific Coast, $80 million, considered.

Hydrocarbons Pipeline, Ltd., Winnipeg, Manitoba, 880 miles, 6-8 inch, products, from Edmonton to Winnipeg, $35 million, partial authorization.

Independent Pipe Line Co., 2,019 miles, 34-36-inch, crude, Edmonton to Montreal, 23,000 pump horsepower, $395 million, before Borden Commission.

Interprovincial Pipe Line Company, 350-mile extension from Toronto to Montreal, looping line from Edmonton to Toronto, crude, $240 million, considered.

6,150 hp pump station at Iron River, Mich., and 4,450 hp addition at Edmonton, Alta., $2 million, planned.

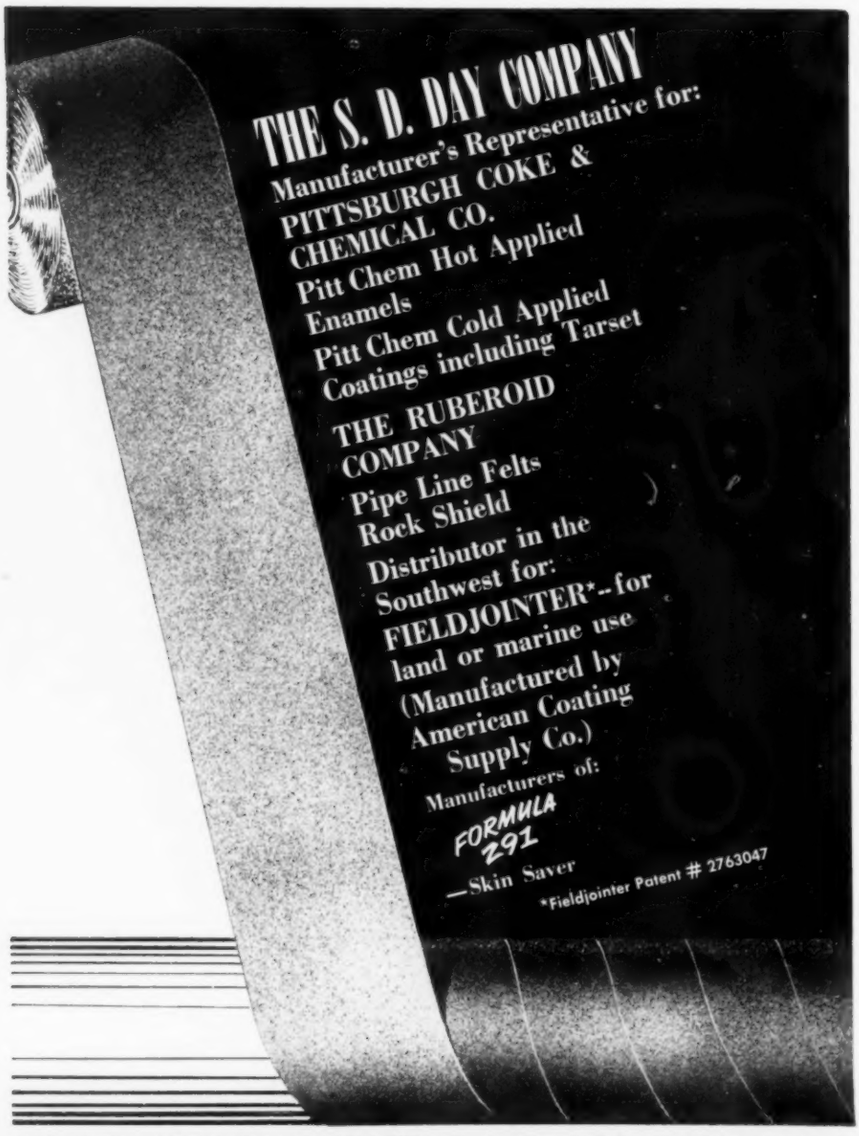
Iranian Oil Exploration and Producing Co., 97 miles, 30-inch, crude, Gash Saran to Kharg Island, $56 million, contracts let to Collins Submarine Pipelines Overseas, Ltd., Raymond Concrete Pile Company; Williams Brother Co., Werkspoor & Bredero, Constructors John Brown Ltd., and Richard Costain Ltd.

Iraq Petroleum Company, 25 miles, 32-inch, crude, twin lines, from Foa to terminal in Persian Gulf, contract let to Collins Submarine Overseas Pipelines Ltd.

80 miles, 30-32-inch, crude, loop line, Rumaila field to Fao, Iraq, planned.

Mid-Continent Pipe Lines, Ltd., 1500-mile, 30-inch crude, Edmonton to Chicago, planned.

NATO, 211 miles, crude, 6-inch, between Malatya-Cetinkaya-Erzincan, Turkey, $ million, bids asked.



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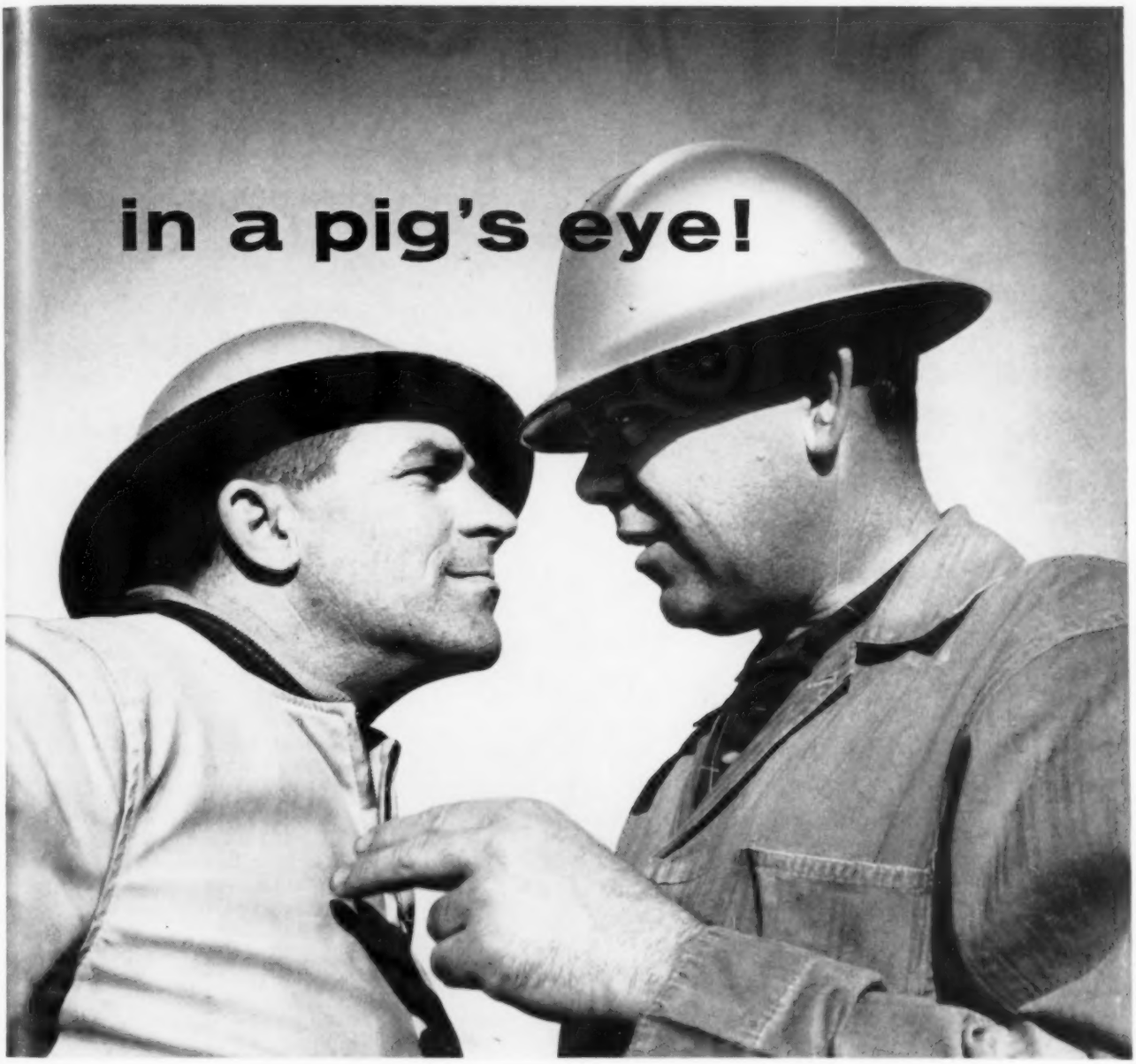
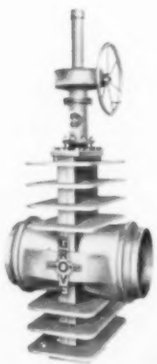


THERE IS A DIFFERENCE IN VENTURI VALVES



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Even with a port reduction of two to four basic pipe sizes, Grove Seal-O-Ring Venturi Valves have comparable flow capacity and pressure loss to so-called "full ported" rectangular port plug valves. And, they cost less too.

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OPERATES BY THE MERE TURN OF A SWITCH

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Here is a new, compact, economical and dependable LimiTorque Motorized Operator for use on small (normally hand-operated) Globe and Gate Valves — either new or already in service. Your existing hand-operated valves can now be easily motorized by the removal of the hand-wheel, and mounting the P-2 Unit on the same bonnet . . . the Unit output drive sleeve will then drive the hand-wheel unit, which arrangement is suitable for both rising and non-rising stem valves.

The P-2 LimiTorque Operator has a standard out-put speed of 22.5 or 45 rpm, which covers the average and recommended operating speed for most Globe and Gate Valves.

Remember, this new P-2 LimiTorque is built by the largest manufacturer of Motor Operators for Valves in the World . . . backed by nearly 30 years experience.

BE CONVINCED how the P-2 can save you time, labor and money in the operation of small valves — just write for Bulletin No. 21-58, which not only illustrates and explains its operation, but shows how easily it can be installed on existing or new valves.

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National Iranian Oil Co., 146 miles, 6 inch, crude, from Azna to Isfahan, Iran, $5 million, planned.

1000 miles, 38 inch, crude, from central Iran to the Turkish Mediterranean coast, considered.

Peace River Oil Pipe Line Co., Ltd., 70-mile, crude, Swan Hills to Iosegun Junction, approved.

Pembina Pipe Line, Ltd., Edmonton, 1,200 miles, LPG, from Alberta gas fields to eastern Canada, planned.

Petroleos Mexicanos, 38 miles, 4 inch, products, from Mexico City to Toluca, $500,000 planned.

126 miles, 4, 6 and 8 inch, products, from Mexico City to Cuernavaca and Puebla, $2.5 million, planned.

Pipelines of Puerto Rico, Inc., 95 miles, 8-inch, products, Penuelas to San Juan, Puerto Rico, planned.

Sociedad Nacional de Oleoductor, 75 miles, crude, from Santiago-to-Valparaiso, $3 million, planned.

Societa Nazionale Metanodotti, 250 miles, 18-inch, crude and products, Genoa to Milan-Cremona-Torino, Italy, and Geneva, Switzerland, considered.

Sui Gas Transmission Co., Multan, Punjab, India, 145 miles, 8-inch, gas, from Sylhet to Dacca, East Pakistan, $9 million, considered.

130 miles, 16-inch, gas, main line, Multan to Lyallpur, planned.

Trans-Canada Pipe Lines Limited, Toronto, compressor stations at Ignace, Geraldton and Hearst, Northern Ontario, and Maple, north of Toronto, $15.5 million, planned.

Trans-Europe Pipe Line, 700 miles, 30 inch, main trunk, crude, from Mediterranean to northern Europe, considered.

Trans-Prairie Pipelines, Ltd., Edmonton, crude line, from Weyburn field to Regina-Moose Jaw areas, $5 million, considered.

Union Gas Company of Canada Limited, 45 miles, 8-inch, gas, main, Stratford to Goderich, Ontario; 10-miles, 8-inch, main, to Amhertburg; 10-miles, 12-inch, lateral, Galt to Brantford, planned.

Van Tor Oil & Exploration Co., Vancouver, B. C., 25 miles, gas, Vancouver Island to mainland, planned.

Westcoast Transmission Company, Ltd., 174 miles, 30-inch, gas, Savanna Creek gas field, Alberta, to British Columbian border, $45 million, planned.

650 miles, crude, from Peace River area to Vancouver, $100 million, planned.

Williams-McWilliams Industries, Inc., New York, 441 miles, 6-inch, crude, Villa Montes, Bolivia to Villa Hayes, Paraguay, considered.

Yacimientos Petroliferos Fiscales, Buenos Aires, Argentina, 621 miles, 12-inch, products, Mendoza to San Lorenzo, Argentina, $19 million, planned.

281 miles, 12¾ inch, crude, Pichanal to San Miguel Tucuman to Techint, S. A., planned.

450 miles, 16-inch, crude, from Neuquen Province to Bahia Blanca, planned.

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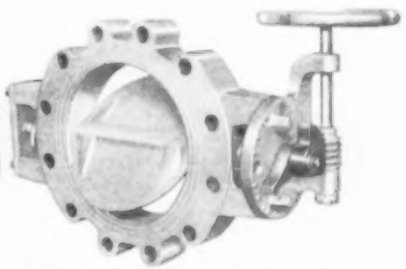
"WAFER" VALVES



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Standard 125-150 lb. wafer butterfly valve with handwheel, also available with lever control or mechanical operators.

For controlled throttling or tight shut-off of air, gases, process fluids or semi-solids, Rockwell Wafer Butterfly Valves offer the advantages of rugged construction, compactness, small face-to-face dimension to fit in minimum clearance between pipe flanges.

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What's Happening

among MEN in the INDUSTRY

P. J. King, Jr.

T. L. Pelican

Colorado Interstate Gas Company has announced the election of two vice presidents and a treasurer. Peter J. King, Jr., is vice president for corporate financial matters and Thomas L. Pelican is vice president, engineering. John J. Yeonopolus was named treasurer replacing William B. Kice, who recently retired.

J. J. Yeonopolus

King has been with Colorado Interstate since 1953; previously he had been with the U.S. Atomic Energy Commission. Pelican joined the company as a gas engineer in 1948 and has been in charge of the industrial engineering department since 1953. Yeonopolus has been affiliated with Colorado Interstate since 1941 and was named a rate accountant in 1951. He was made director of budget and rates in 1957.

Texas Eastern Transmission Corporation will move its offices of financial vice-president, treasurer, secretary and director of public relations to Houston.

Robert J. Fitzpatrick, director of public relations, has transferred to Houston. Other officers will move from Shreveport to Houston soon.

Buckeye Pipe Line Company announces the appointment of **E. William Glanton** as purchasing agent of the company and its subsidiaries, **Northern Pipe Line Company** and **New York Transit, Inc.**

Glanton has been with Buckeye since 1944 and after five years as general manager of Indiana Trunk Line division was transferred to the New York office in 1956 as assistant personnel director.

Texas Petro Gas Company, Houston, has been formed with **Forrest S. Warren** as president. The new firm will emphasize pipe line movements as well as production and marketing of propane, butane, natural gasoline and other products of the natural gas industry.

Warren resigned as vice president of Texas Natural Gas Gasoline Corp. Other directors of the company include **Henry Groppe**, partner in the firm, Mares and Groppe, Houston chemical consultants, and **John H. Crooker, Jr.**, of law firm, Fulbright, Crooker, Freeman, Bates and Jaworski.

A. Carl Gladden has been promoted to executive vice president as well as treasurer for **Texas Gas Corporation** and **Texas Gas Pipe Line Corporation. John L. Buvens**, vice president in charge of gas supply and sales, was made a member of the board of directors.

Gladden joined the company in 1951 as chief accountant. Until his recent appointment, he had served as vice president and treasurer.

George R. Brown, executive vice president of **Brown & Root, Inc.**, has been named a member of the Commerce Business Advisory Council. **S. D. Bechtel**, president **Bechtel Corporation**, was re-elected chairman.

The council is made up of about 150 industry leaders. It meets with secretaries of commerce to present the business viewpoint on economic questions.

Mountain Fuel Supply Company announces the appointment of **L. C. Peschel** as a director of the company replacing **L. Clyde Olpin** who recently resigned.

Peschel has been affiliated with Mountain Fuel since 1920 and is controller of the company. He was made chief accountant of the company in 1949 and in 1951 became controller.

Officers elected by the **NACE** for 1959-60 will be installed at the association's annual conference in Chicago, March 16-20.

Hugh P. Godard, Aluminum Laboratories, Ltd. was elected president; **George E. Best, Solvay Process Div., Allied Chemical Corp.**, vice president, and **A. L. Stegner, Tennessee Gas Transmission Company**, treasurer.

Jack R. Fraser has been elected vice president in charge of the newly formed gas department for **Republic Natural Gas Company.** Previously Fraser had been senior engineer responsible for all Republic's gas contracts and matters pertaining to FPC.

He was a distribution engineer for Equitable Gas Company in 1941, exploitation engineer with Shell Oil Company and later was affiliated with Texas Eastern Production Corporation as chief engineer from 1953 to 1956. He joined Republic in 1956.

H. W. Collins has been appointed manager of **Aurora Gasoline Company's** crude oil supply, procurement and transportation and pipe line operations.

He will continue to serve as manager of marine properties and vice president and manager of **Michigan Tankers, Inc.**, subsidiary of Aurora. **W. C. Gleich**, manager of crude oil supply, will assist Collins in terminal, pipe line and marine operations.

Howard D. White, executive vice president of the **Liquefied Petroleum Gas Association** has been named a member of the National Petroleum Council, a group of industry executives which advises the government on petroleum and gas problems.

Southwestern Gas Measurement Short Course

The 34th annual Southwestern Gas Measurement Short Course will be held at the College of Engineering, University of Oklahoma, Norman, Okla., April 14-15. Committee chairmen pictured above include, seated left to right, R. R. McCafferty, program; R. F. Nowlin, chairman; W. H. Carson, general arrangements; and Thelma T. Jones, publicity. Standing, left to right, Charles R. Stephenson, practical methods and registration; Charles D. Peterson, exhibitors; William B. Ruff, Jr., exhibits, and Howard S. Gray, publications.

the right combination

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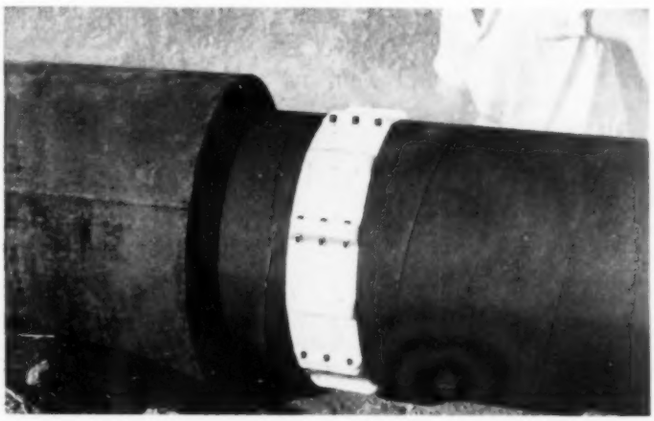

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Clifton D. Campbell has been named superintendent of communication for the **Houston Corporation** and its subsidiaries, **Houston Texas Gas & Oil Corporation** and **Coastal Transmission Corporation.** Campbell for the past 18 years had been with Humble Pipe Line Company.

C. D. Campbell

Campbell also will be in charge of corrosion and all electrical maintenance for the Houston Corporation with his headquarters in St. Petersburg, Fla.

Charles Pennypacker Smith has been elected vice president and manager of **Alberta and Southern Gas Company Ltd.,** Canadian subsidiary formed by **Pacific Gas & Electric Company.**

Smith was also named to the A&S board of directors. Since moving to Calgary in 1957, Smith has served as manager of operations for Alberta and Southern, directing negotiations with Alberta producers for gas reserves. He joined Pacific Gas & Electric in 1937. In 1954 he was named supervising gas supply engineer.

John F. Merriam, president of **Northern Natural Gas Company,** was elected president of the newly formed **Helex Company.** Other officers of the new company which was created to extract helium from natural gas are: **M. L. Mead,** senior vice president; **F. C. Nicholson,** vice president; **W. H. Thomas,** vice president sales; **B. H. Harper,** secretary; and **H. H. Siert,** treasurer.

Directors include Merriam, Mead, and **A. B. Dilworth** of Northern Natural and **Leonard Pool** and **Edward Donlay** of Air **Products, Inc.**

Charles C. Whittelsey, president of **Ford, Bacon & Davis, Inc.,** has been elected chairman of the board succeeding **Everett S. Coldwell,** who retired after 3 years with the firm.

Whittelsey will continue as president and chief executive officer. He joined the company in 1925 and succeeded Coldwell as president in 1957. He served in the construction and engineering department, building many pipe line systems for the natural gas and petroleum industry.

Coldwell joined the company in 1926 he was elected vice president in 1941, director in 1942 and president 10 years later.

V. W. Meythaler has been elected vice president and treasurer of **Texas Gas Transmission Corporation.** Meythaler has been with the company since 1949. He was named assistant treasurer in 1953 and treasurer in 1955.

V. W. Meythaler

Prior to his employment with Texas Gas, he served in accounting positions with Hart Carter & Co., Monelle Corporation, and W. E. Krieger Certified Public Accountants.

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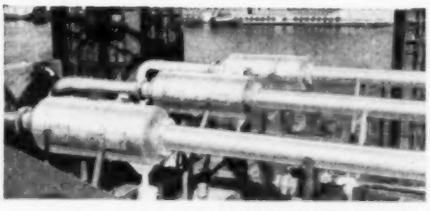
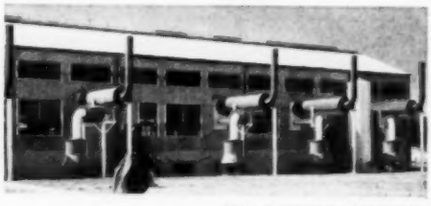


OIL WELL DRILLING RIGS



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- ☐ Air compressor intakes and discharges
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WHO'S MEETING WHERE

March

ASME, gas turbine power conference and exhibit, Netherlands-Hilton Hotel, Cincinnati, March 8-12.

Midwest Gas Association, annual meeting, Hotel Fort Des Moines, Des Moines, Iowa, March 9-11.

NACE, 15th annual conference, Sherman Hotel, Chicago, March 16-20.

New England Gas Association, annual meeting, Hotel Statler, Boston, March 19-20.

IRE, national convention, New York coliseum and Waldorf-Astoria Hotel, New York, March 23-26.

April

Sixth Gas Compressor Institute, sponsored by University of Kansas and Southwest Kansas petroleum industry, Randall's Cafeteria, Liberal, Kansas, April 6-7.

AGA Operating Section Distribution conference, Netherland-Hilton Hotel, Cincinnati, April 6-9.

American Welding Society, 40th annual convention, Sherman Hotel, Chicago, April 6-10.

PIEA, PESA, joint meeting, Moody Center, Galveston, April 7-9.

ASME, hydraulics conference, University of Michigan, Ann Arbor, Mich., April 13-15.

Southwestern Gas Measurement Short Course, University of Oklahoma, Norman, Okla., April 14-16.

Conference on Industrial Instrumentation and Control, Illinois Institute of Technology, Chicago, April 14-15.

API, division of transportation, annual tanker conference, Jung Hotel, New Orleans, April 15-17.

ASME, oil and gas power conference, and exhibit, Shamrock-Hilton Hotel, Houston, April 19-23.

Natural Gasoline Association of America, 38th annual conference, Baker and Adolphus Hotels, Dallas, April 22-24.

Indiana Gas Association, French Lick-Sheraton Hotel, French Lick, Ind., April 22-24.

ASME, metals engineering conference, Sheraton-Ten Eyck Hotel, Albany, N. Y., April 29-May 3.

May

LPGA, 28th annual meeting, Conrad Hilton Hotel, Chicago, May 3-6.

API, safety and fire protection committees, 12th midyear meeting, Rice Hotel, Houston, May 4-8.

API Division of Transportation, annual pipe line conference, Penn-Sheraton Hotel, Pittsburgh, May 13-15.

International Petroleum Exposition, exhibit of oil industry equipment, Tulsa, May 14-23.

AGA, operating section transmission conference, Statler-Hilton Hotel, Dallas, May 18-19.

Pennsylvania Gas Association, Pocono Manor Inn, Pocono Manor, Penn., May 19-21.

ASME, design engineering conference, Convention Hall, Philadelphia, May 25-28.

14th Annual Short Course in Gas Technology, Texas College of Arts and Industries, Kingsville, Texas, May 27-29.

Fifth World Petroleum Conference, The Coliseum, New York City, May 31-June 6.

June

Society of Automotive Engineers, summer meeting, Chalfonte-Haddon Hotel, Atlantic City, June 14-19.

ASME, applied mechanics conference, Virginia Polytechnic Institute, Blacksburg, Va., June 18-20.

American Society for Testing Engineers, annual meeting, Chalfonte-Haddon Hall, Atlantic City, June 21-26.

Michigan Gas Association, meeting, Grand Hotel, Kackinac Island, June 22-23.

Canadian Gas Association, annual meeting, Empress Hotel, Victoria, B. C., June 22-24.

In the U.S.A. for the First Time

New York City will be host to this great international event which will be attended by thousands of the world's leading oil men from over 45 countries.

Packed With Important Benefits for You!

At the 5th World Petroleum Congress Exposition, there will be more than 275 fact-filled exhibits demonstrating the newest equipment, techniques, services and materials that have been recently developed for use in the petroleum and petrochemical industries.

It's your special opportunity to see, discuss and compare these latest developments for use in oil research, production, refining, transportation . . . plus nuclear energy applications.

Plan now to attend . . . and bring your key men with you. Their visit will stimulate fresh thinking and new approaches to many problems—just one idea picked up here will make their trip more than worthwhile.

For advance registration and hotel information write the Exposition at 480 Lexington Avenue, New York 17, N. Y. 1240

5th

WORLD PETROLEUM CONGRESS EXPOSITION

New York Coliseum

June 1-5, 1959

Management: International Exposition Co.

From the desk of **J. L. MARTIN**

Don—

Have you seen these latest figures on cathodic protection costs on pipelines? They're based on one mile of 24" pipe after several years of service—

Coating	Resistance (ohms/sq. ft.)	Installation	Annual Upkeep
Coal Tar Enamel	300,000+	$112.	$33.
"Economy" Enamel	10,000-	$2,740.	$520.

I'm convinced we can hardly afford to use anything but coal tar for our new line.

Let's specify Pitt Chem Modified Coal Tar Enamel. I understand they make top quality products—and back them up with excellent technical field service.

Jim

★ PITT CHEM® Coal Tar Pipeline Enamels
★ PITT CHEM "Tarmastic"® Coal Tar Coatings
★ PITT CHEM "Tarset"® Coal Tar-Epoxy Resin Coatings
★ PITT CHEM "Insul-Mastic"® Gilsonite-Asphalt Coatings

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What's Happening among SERVICE and SUPPLY MEN

William E. Hutchins Appointed District Manager of Tube Forgings

William Hutchins has been named to fill the new post of southwest district manager for Tube Forgings of America, Inc., with headquarters in Houston.

W. E. Hutchins

Hutchins for the last three years has been a member of Tube Forgings' western sales staff in Portland, Ore. The Houston office is the latest addition to a growing list of distributing offices for Tube Forgings. Next branch office will be established in Tulsa.

Ken Bradshaw Forms Bradshaw Steel and Forge Co.

Ken Bradshaw has formed the Bradshaw Steel & Forge Co., Panama City, Fla. The company will manufacture steel forgings, flanges, welding fittings and pipe fittings.

Officers of the new firm include W. J. Mann, controller and director of the accounting department and Bill Phillips, sales manager. Mrs. Rex Huddleston is executive secretary.

Jones & Laughlin Names New District Managers

Jones & Laughlin Supply Division announces changes in its Kansas, Texas, Oklahoma, and New Mexico districts. New districts include Western Kansas district with headquarters at Great Bend, Kansas; Southern Oklahoma district with headquarters at Admore, Okla. and the New Mexico district with headquarters at Hobbs, N. M.

W. R. Layne will head the Southern Oklahoma district as sales manager. J. K. Guinn will be district sales manager of the Central Oklahoma district and A. A. Hopper is sales manager at the Eastern Oklahoma district. Eastern Kansas district is under the direction of J. A. Carrigan and J. A. Beaird is district manager of Western Kansas district G. A. Whiteker is district manager of West Texas area and R. L. Daniel becomes manager of New Mexico district.

Jack R. Martin Named Midwestern Sales Manager

Jack R. Martin has been named sales manager, Tulsa division of Midwestern Engine & Equipment Co., Inc. Martin has been with the company since 1957. Prior to his association with Midwestern he had been with Standard Industries, Inc. and the Eugene Dietzen Company

Martin will supervise the sale of Midwestern's complete line of general contracting, earthmoving and pipe line equipment.

W. F. Kruegar Selected To Head New Department

Dresser Manufacturing Division announces formation of a new department for the sale of oil and gas transmission pipe line products. An extensive line of pipe line installation and maintenance products are under development and field test and will be introduced soon.

W. F. Kruegar

W. F. Kruegar has been appointed head of the department. He joined Dresser in 1956 and has been closely associated with the research and product development program for transmission lines since.

Marlow Pumps Division Appoints Stork Manager

E. C. Stork has been appointed manager of the Longview, Texas, plant for Marlow Pumps Division, Bell & Gossett Co.

Stork joined Marlow in 1954 as a district sales engineer covering parts of Texas, Louisiana, Mississippi, Arkansas and Tennessee. Prior to coming to Marlow, Stork owned and operated his own automotive supply business.

Add-A-Stack
Custom Line
Type-N
Good-All
CATHODIC PROTECTION RECTIFIERS
Gemco
Low-V

The "Quality" Line

We look forward to seeing you at

BOOTH 125
National Association of Corrosion Engineers Show
Chicago March 16-20
Electrical Mechanical Division

GOOD-ALL ELECTRIC MFG. CO.
OGALLALA, NEBRASKA

Sparkey Sez

Main Frames, Bed Plates, and A-Frames, when fractured, can be repaired on the job site by *Exline's* special *Welding* process.

FOR EMERGENCY REPAIRS, CALL ON

Exline Engine Works
SALINA, KANSAS
Box 446 TAylor 3-4683

Go-Devil

Heavy Duty Model Northrup Go-Devil with Neoprene cup or disc drivers

G. A. COTTEN CO.
Manufacturer of
NORTHRUP GO-DEVILS & TRANSIT PIPE LINE SCRAPERS
P. O. Box 5332 — Tulsa, Okla.

NOW coming your way...

...a NEW Parsons® 420 Trenchliner

CAPACITIES . . . SPECIFICATIONS . . . FEATURES:

trench widths — 36 to 52 inches

maximum digging depth to 7½ ft.

15 digging speeds from 15.1 in. to 25 lineal ft. per minute

double-action hydraulic rams actuate digging wheel for grading or travel

shiftable, reversible conveyor that's hydraulically driven

formed steel-plate buckets have replaceable point-type teeth — are available with tine or solid backs

120 h.p. diesel engine

24-in. crawlers, tractor-type with replaceable links, pins, bushings

Developed especially for cross-country work, and other big trenching jobs Parsons new 420 Trenchliner® has the extra capacity needed to profitably handle your big work schedules. Digging from 36 to 52 in. wide at depths to 7½ ft., this heavy-duty wheel-type machine produces up to 25 lineal feet of trench per minute. For more facts on this big production 420 Trenchliner call Parsons distributor *now*, or write. Other Parsons wheel-types include smaller 130, 150, 170 and larger 520.

mail to: PARSONS COMPANY, NEWTON, IOWA *(A Division of Koehring Co.)*

Send more information on new 420 Trenchliner

NAME .....

TITLE .....

COMPANY .....

STREET .....

CITY, STATE .....

P931 PI

TRENCHLINERS for PIPELINERS

General Electric Appoints Strehle, Najork Managers

John E. Strehle has been appointed Southern Florida district sales manager at Pompano Beach and Jack Najork has been in charge of the two-way radio office in Chicago for General Electric's Communication Products Department.

Strehle was communications engineer for the department in Tampa. Najork formerly was in charge of G-E two-way radio sales in Southern Illinois.

Midwestern Names Slack Sales Representative

Robert D. Slack has been appointed sales representative for Midwestern Pipe Line Products Company for Iowa, Nebraska, Kansas and Missouri area.

Slack had been employed as sales engineer in the Chicago office of the Walworth Company, following operation of his own engineering and design firm in Des Moines, Ia.

E. A. Murray

Everett L. Case

E. A. Murray Selected Manager Of Worthington's New Division

E. A. Murray has been appointed manager of the newly combined sales and service at Worthington Corporation Compressor and Engine Division, Buffalo, N. Y. Murray had been serving as manager of compressor sales and will be replaced by Everett L. Case.

Murray joined Worthington in 1935 as sales application engineer in compressor sales department. He served as assistant manager of compressor sales then manager of compressor sales.

Case has been with the company since 1937. He served as compressor application engineer, special technical advisor and coordinator to the purchasing department. In 1954 he was named assistant manager of compressor sales.

Tube Turns Plastics Names Dever Assistant Manager

Tube Turns Plastics, Inc. announces the appointment of Charles M. Dever, Jr., as assistant manager of its Midwest district in Chicago.

Dever has been with the company since 1956 and has been manager of sales service for the past year.

R. W. Kearney Appointed Tex-Tube Sales Manager

Tex-Tube, Inc. announces the appointment of R. W. Kearney as manager of sales replacing William S. Beall who has been named a vice president.

Kearney has been with the company since 1952. Previously he had been with Magnolia Petroleum Co.

Several Managerial Changes Announced by Allis-Chalmers

Allis-Chalmers Manufacturing Company announces several appointments in district positions. Joseph Varacalli, formerly distributor supervisor for the Northeast Region, has been appointed supervisor of original equipment manufacture and distributor sales for New York district.

E. E. Strickland, formerly manager of industrial sales for New York has been made manager of general products division sales for the Industries Group's Northeast Region.

R. H. Porterfield becomes manager industrial sales, New York and W. T. Farnsworth is manager of the Hartford, Conn., district. Porterfield had been manager of Hartford district since 1954. Prior to that he was manager of the Providence, R. I., district for eight years. Farnsworth had been sales representative in Hartford since 1953.

Elston Made General Manager Of General Electric Gas Turbine

Charles W. Elston has been appointed general manager for General Electric Company's Gas Turbine department. He succeeds Lewis J. Burger who has been named general manager of the Switchgear and Control division. Elston has been with the company since 1937. In 1947 he was named assistant to the designing engineer in charge of large steam turbine design. In 1949 was named manager-engineering for the Gas Turbine department, the position he retained until his recent promotion.

Jones, Scamman Join Cathodic Protection Service

David H. Jones and Charles W. Scamman recently joined the sales division of Cathodic Protection Service. Scamman formerly was with Houston Oil Field Material Company. Jones will be placed in charge of the company's Chicago office. For the past two years Jones had been manager of cathodic protection sales for the Duriron Company; previously he had been branch manager for Duriron.

Paul L. Patterson Becomes Representative for Wheatley

Frank Wheatley Supply Company has announced the appointment of Paul L. Patterson as the firms special sales representative in the Houston area.

Patterson had been with Goodyear Tire & Rubber Company eight years before joining Wheatley. Presiously he had been associated with the Thermoid Company in Houston.

W K-M Appoints Butler Sales Manager-Plug-Valves

Robert D. Butler has been appointed sales manager-plug-valves for W-K-M, division of ACF Industries, Incorporated. Butler has five years experience with the company as a sales representative in southeastern United States. In 1958 he had been promoted to assistant sales manager-plug-valves.

H Bruce Finch Controller For F. H. Maloney Company

H. Bruce Finch has been elected controller of F. H. Maloney Company. He formerly was associated with the Houston Bank & Trust Company. Prior to joining Maloney, he had been with Oil Properties firm.

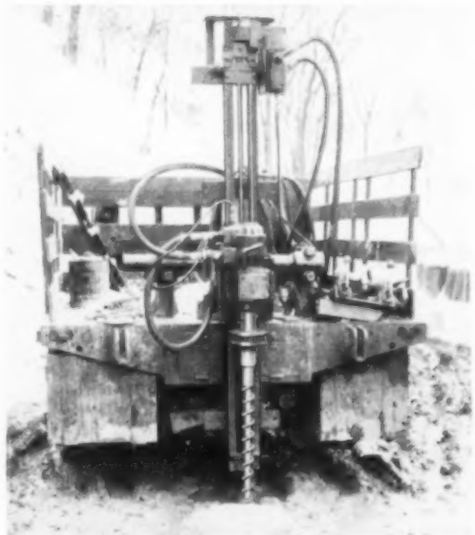
KA-MO has the answer to your drilling problem

48-foot bore —

To run a gas distribution line under main highway, the pipeline contractor on this job used a portable Ka-Mo horizontal drill . . . quickly bored a 12" diameter hole, 48' long, through hard clay. Drill was powered by a 7½ h.p. air motor on a standard double-track mounting. On similar type work, casing can be installed at the same time hole is drilled by using the casing attachment which provides maximum protection against costly cave-ins.

Ka-Mo offers tremendous versatility . . . light, portable drills . . . easy to operate for installing gas lines under streets, highways, railroads. Drills through sand, clay, gumbo, frost, shale, limerock, other mineral formations. Air, electric, hydraulic, diesel or gasoline engine powered.

Vertical drilling for cathodic pipe protection



Ka-Mo truck mounted hydraulic unit used to simplify installation of anodes. This drill is available in sizes from 6" to 24" diameter. Gravity or pressure feed.

Next time you have a drilling problem, check the Ka-Mo line. Drill sizes: 2" to 48" dia. and larger, in sectionalized lengths, are tailored to meet your own particular requirements. Information is available at no obligation. Just mail coupon today.

Mail to: KWIK-MIX CO., Ka-Mo Tools Dept., 1845 South 55th Ave., Cicero 50, Ill.

NAME .....
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Send free data on:
☐ horizontal ☐ vertical
☐ angular drilling equip.
☐ pipe anchor installation
Dia. of hole ..... inches
Length of bore ..... feet
Type soil .....

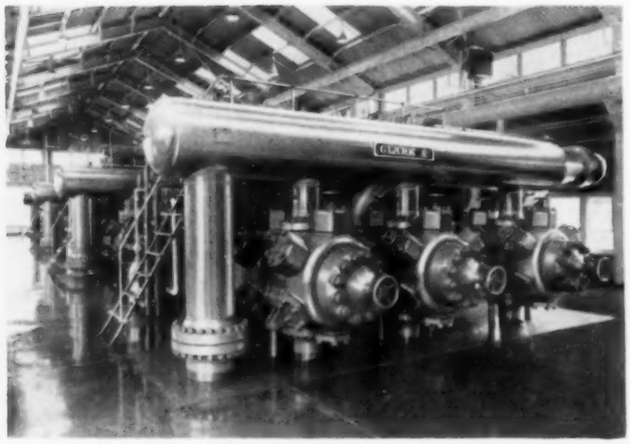
KAM904 PI

KWIK-MIX COMPANY — Ka-Mo Tools Dept.
A DIVISION OF KOEHRING COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

What's New in EQUIPMENT

To receive more information on all new equipment articles use Readers' Service Card, last page of this issue.



Clark's 2-cycle turbocharged compressor for pipe line application (left) is equipped with new valves (right) featuring streamlined nylon poppets which lower gas velocity.

Clark Develops New Pipe Line Compressor Cylinder

Developed as a result of four years research and field testing, Clark Bros. Co.'s new pipe line compressor cylinder incorporates a new valve design, large internal manifolds and oversize suction and discharge nozzles to keep velocity low.

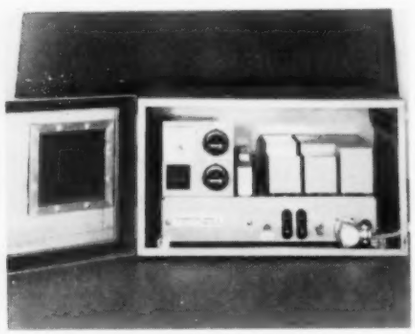
The valves utilize nylon poppets for extra long life and are designed to hold the velocity of the gas at a low level. Because gas flow through the valve is unrestricted, fewer valves per cylinder are required. Double-decking of valves is not necessary in most cases.

A great reduction in maintenance is brought about through use of nylon poppets. Because of the high free lift area, the pressure drop across valve is substantially reduced.

Clark engineers say that performance records established under field conditions have shown a 15 percent improvement in efficiency over previous designs. In addition to improvements at higher ratios, greater gains have been made at ratios 1.2 and lower, without sacrificing the wide loading flexibility which is important in pipe line compressor station operation.

(This item supplements Clark Bros. Co. data on pages 89-92 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E1** on Readers' Service Card, last page this issue.



Electronic Flow Computer

Computers, Inc., announces its electronic flow computer which has been put in use on a pipe line system for gas measurement.

The instrument utilizes the gas meter run and orifice plate as the basic measuring system with data from the meter run being led into a special analog computer. Transducers connected to the meter run measure static differential pressure and temperature of the flowing gas through the orifice plate in the meter run and from which electrical signals are transmitted to the computer. From signals supplied by the transducers, the computer corrects the flow of gas to base contract conditions instantaneously, eliminating any further correction factors. Computed flow rate is supplied to a magnetic integrator which gives an electrical pulse for a preselected increment of volume in standard cubic feet. This pulse is then used to operate a mechanical counter which gives a visual indication of accumulated corrected volume on an indicator.

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

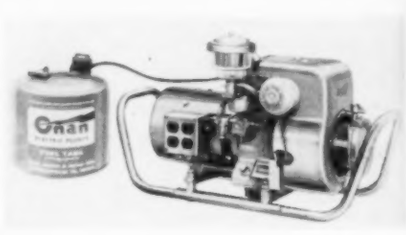
Reaction Torque

Allis-Chalmers Manufacturing Company announces a new reaction torque tilting motor base for automatic belted drive tension control under changing load conditions.

Engineered on the principle that action and reaction are equal but opposite, the motor base's reactive torque is directly proportional to the horsepower. The belt tension increases and decreases as the load varies.

(This item supplements Allis-Chalmers Manufacturing Company data on pages 41-44 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E3** on Readers' Service Card, last page this issue.



Generating Plant

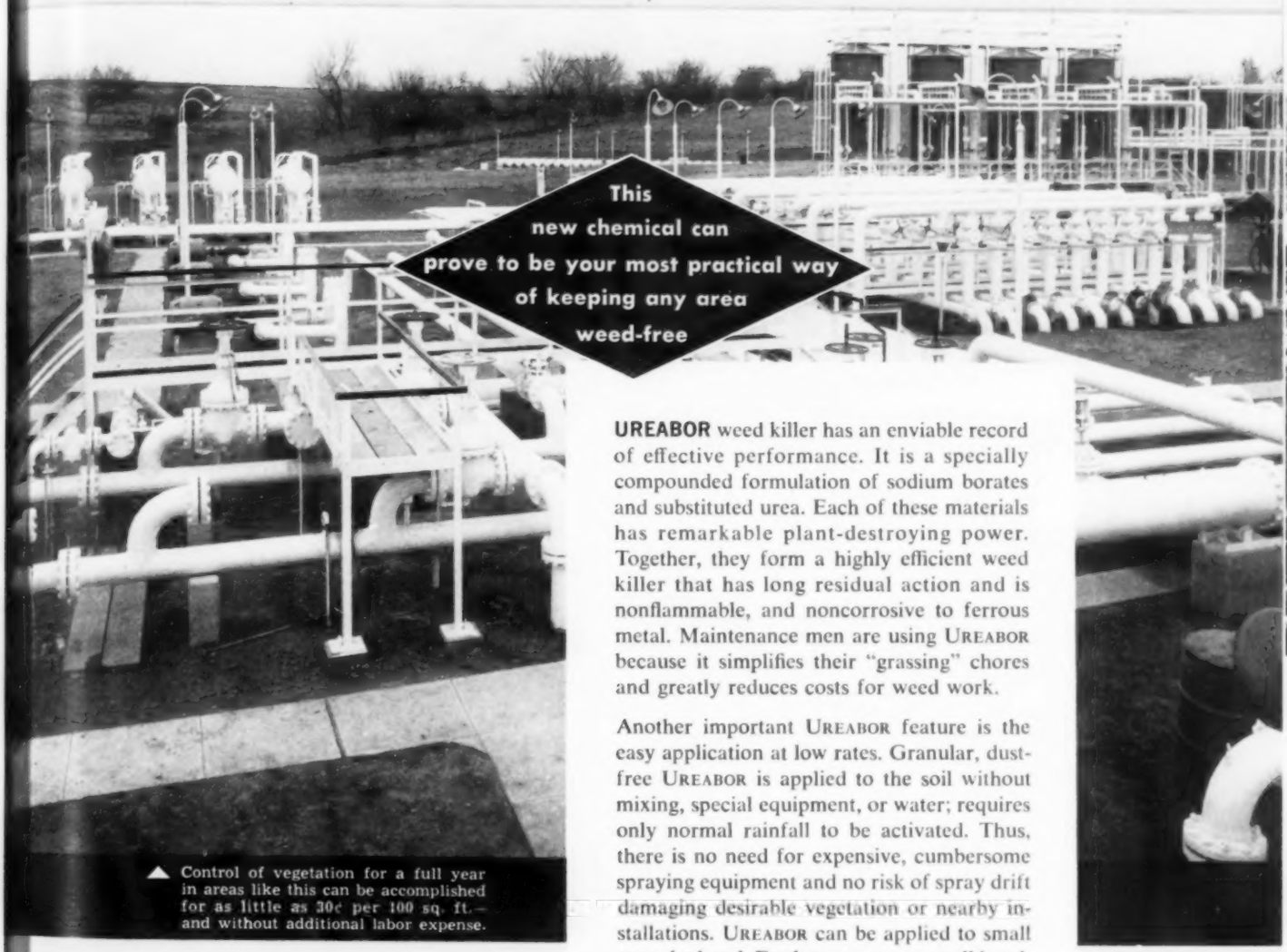
D. W. Onan & Sons Inc., has developed a new lightweight 2,500-watt electric generating plant designed for portable and/or emergency standby.

The gasoline engine-driven generator set is used as a heavy-duty power plant on a construction site and as a source of standby power for business or small institution used. Completely self-contained, the versatile unit will provide full-rated A.C. power to run electric tools, lights and motors for contractors.

Both models are identical in weight and size with the exception that the contractors unit is equipped with an aluminum carrying frames, making over-all dimensions slightly larger.

For more data, circle **No. E4** on Readers' Service Card, last page this issue.

Now...controlling vegetation is easier-cheaper-
with **UREABOR®** weed and grass killer



▲ Control of vegetation for a full year in areas like this can be accomplished for as little as 30¢ per 100 sq. ft.—and without additional labor expense.

UREABOR weed killer has an enviable record of effective performance. It is a specially compounded formulation of sodium borates and substituted urea. Each of these materials has remarkable plant-destroying power. Together, they form a highly efficient weed killer that has long residual action and is nonflammable, and noncorrosive to ferrous metal. Maintenance men are using UREABOR because it simplifies their "grassing" chores and greatly reduces costs for weed work.

Another important UREABOR feature is the easy application at low rates. Granular, dust-free UREABOR is applied to the soil without mixing, special equipment, or water; requires only normal rainfall to be activated. Thus, there is no need for expensive, cumbersome spraying equipment and no risk of spray drift damaging desirable vegetation or nearby installations. UREABOR can be applied to small areas by hand. For larger areas, a small hand-operated sling strap spreader is available.

UREABOR weed killer is conveniently packaged in easy-to-handle 50-lb. multi-wall paper sacks. It is economical, always ready for use—dry. To learn more about UREABOR—write:

AGRICULTURAL SALES DEPARTMENT
United States Borax & Chemical Corporation
PACIFIC COAST BORAX COMPANY DIVISION
630 SHATTO PLACE • LOS ANGELES 5, CALIFORNIA

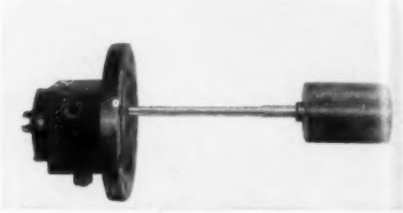
Tip, Tilt Dozer Blade

Caterpillar Tractor Co. has developed a better controlled tilting action dozer blade named the gyrodozer. Two hydraulic cylinders replace the standard tilt braces and provide the hydraulic tip and tilt of the blade. The tilting action made horizontal cuts possible on slopes up to 18 degrees. The 7G blade is basically the same as the 7S blade. Four heat-treated cast steel teeth, fitted into tapered bosses are added. Held firmly in place by the tapered wedges, teeth are made up of three parts—a shank, boot and tip.

The gyrodozer principle adds considerably to the versatility of the bulldozer as a heavy work machine by making it a tool for rough material dozing, raking rock, clearing trees and other right of way work.

(This item supplements Caterpillar Tractor Co. data on pages 76-79 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E5** on Readers' Service Card, last page this issue.



Liquid Level Control

Instruments, Inc., announces a new liquid level control, the Mic-O-Flex, which incorporates the flexible tube principle in its construction to provide an extremely accurate and dependable control unit.

It can be used for high or low limit switches to sound alarms, flash signal lights start or stop fluid transfer pumps, or to operate control valves. It is especially suited for calibrated tanks. The positive displacement float, as used with the Mic-O-Flex, allows the float to operate on any two fluids of dissimilar densities. For this reason it is frequently used to maintain an interface between liquid hydrocarbons and water, as well as between liquid hydrocarbons and vaporous hydrocarbons.

(This item supplements Instruments, Inc. data on page 250 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E6** on Readers' Service Card, last page this issue.

APRIL Control System

A new adjunct to supervisory control equipment for logging data automatically has been announced by General Electric's medium voltage switchgear department.

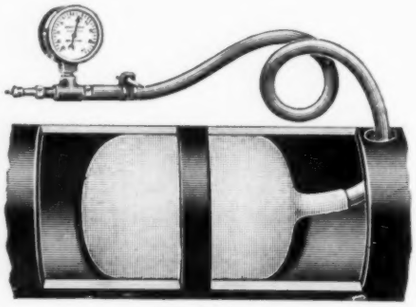
The system, called APRIL (Automatically Programmed Remote Indication Logging), is designed for applications where accurate centralized data transmitting and logging systems are required. It can be incorporated as part of a new supervisory system or added to existing General Electric equipment. Also it can be used on its own channel, or may be used on supervisory channels when required. It can be broadly applied to the pipe line and petroleum industries.

(This item supplements General Electric data on pages 199-202 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E7** on Readers' Service Card, last page this issue.

PIPELINE INFLATABLE STOPPERS

BALLOON-TYPE



OIL, GAS, WATER, SEWER

SIZES 2" TO 48" IN STOCK

SPECIAL SIZES TO ORDER

NATURAL RUBBER OR NEOPRENE

COVERS OF CANVAS, DUCK, DYNEL,

FLAME PROOFED OR ACID RESISTANT.

SAFETY GAS MAIN STOPPER CO. INC.

523 ATLANTIC AVENUE,

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Cable Address
GASTOPPER, N. Y.

Catalogue on Request

SPECIAL PIPELINER BACKHOE SOLVES TRAVELING PROBLEMS

Long, tough pipeline jobs like this 143-mile Texas project call for backhoes that are built to take the wear and tear of continuous travel over rough terrain. American's Pipeline Special is just that—a specially designed pipeliner's machine work-proved on jobs where the going is hardest. This fast, deep digging hoe reaches down 19 feet, 2 inches . . . has exceptional 21-inch ground clearance. Big, husky crawler-tractor side frames and tracks provide positive traction for the powerful, smooth cycling American. Enclosed drive gears and sealed track rollers mounted on anti-friction bearings require a minimum of maintenance . . . cut wear and reduce unscheduled downtime. Get complete facts on the Pipeline Special from the American Distributor in your area—or write direct!

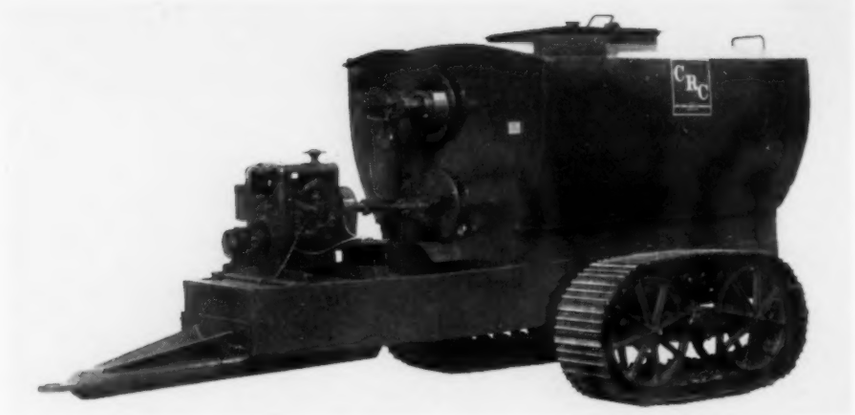
UNUSUAL MOBILITY at minimum operating cost . . . that's the big advantage of American 30-ton 300 Series Self Propelled Cranes that speed pipe handling . . . add versatility and dependable performance—at low operating cost—to spreads of profit-wise operators.

EXCAVATORS-CRANES
to 2 yds.-60 tons
LOCOMOTIVE CRANES
to 130 tons
DERRICKS-HOISTS
to 800 tons
REVOLVER CRANES
to 400 tons

AMERICAN HOIST
and Derrick Company
St. Paul 7, Minnesota

AMERICAN HOIST PACIFIC COMPANY
Special materials handling equipment

CROSBY-LAUGHLIN DIVISION
Drop forged fittings for wire rope-chain



Dope Melting Kettle

Featuring a twin agitation of the filler by a hydraulic-driven sweep and mechanically powered propeller, a new dope melting kettle has been introduced by Crutcher-Rolfs-Cummings, Inc. The kettle also features new side stacks which increase the kettle heating surface area to 95 square feet and fiber insulation for holding the heat longer.

The model SPC requires less heating time in the field, eliminating the need for fuel pumps by using a pressurized fuel tank, and has a highly efficient low pressure burner.

(This item supplements Crutcher-Rolfs-Cummings, Inc., data on pages 139-1 2 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E8** on Readers' Service Card, last page this issue.

is the SPECIALTY of this
WISCONSIN-POWERED Unit

Unique in design and construction, this pumping unit, developed after extended research and experimentation by Harley Sales Company and co-operating manufacturers, provides a practical and efficient means for salt water disposal . . . either in general transfer operations or to disposal wells. Among its refinements, for the first time, a pump of this kind has been equipped with "fluorogreen" valves for high resistance to salt-water corrosion and wear.

A Model AEH Wisconsin Single-Cylinder Heavy-Duty Air-Cooled Engine drives the specially designed F. E. Meyers & Bro. Pump—10 BPH at 400 psi.

This equipment meets a growing need for an economical and practical means to prevent salt-water pollution of streams and surface pollution of land acreage. This is insurance against possible expensive litigation and government citations. Many of these installations are now in use, operating around the clock.

This is a typical oil field assignment for Wisconsin Heavy-Duty Air-Cooled Engines . . . designed and built to "take it" under continuous loads, day after day, month after month . . . in any location, any climate. Rugged, high-quality construction in all details, combined with load-lugging, high torque performance, and self-sustaining operating dependability, are features that keep the equipment going and hold down maintenance costs.

You can't do better than to specify "Wisconsin Power" for your oil field utility units.

A9-6244

WISCONSIN MOTOR CORPORATION
Milwaukee 46, Wisconsin
World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
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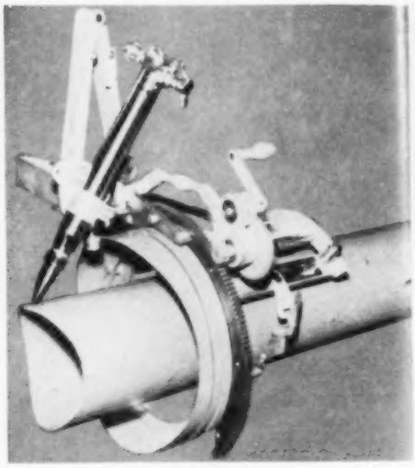
3420 McKINNEY AVENUE • HOUSTON, TEXAS
505 SOUTH MAIN STREET • WICHITA, KANSAS
Oil Field Distributors for Wisconsin Engines and all types of Utility Engines



Beveling Machine

The H&M Pipe Beveling Machine Company has announced improvements in the design of two of the attachments for the standard pipe cutting and beveling machines.

The shape cutter attachment, pictured, has been completely remolded. It is lightweight and features easy, fast mounting. It is designed to cut various shapes of pipe intersections automatically. The Out-of-Round attachment features the addition of a free-wheeling roller assembly that turns a full 360 degrees. This roller rides the surface of the pipe and automatically makes corrections for any imperfections. The advanced design results in increased precision and accuracy when cutting or beveling out-of-round pipe.

(This item supplements H&M Pipe Beveling Machine Company data on page 229 of the Pipe Line Catalog, Second Revision.)

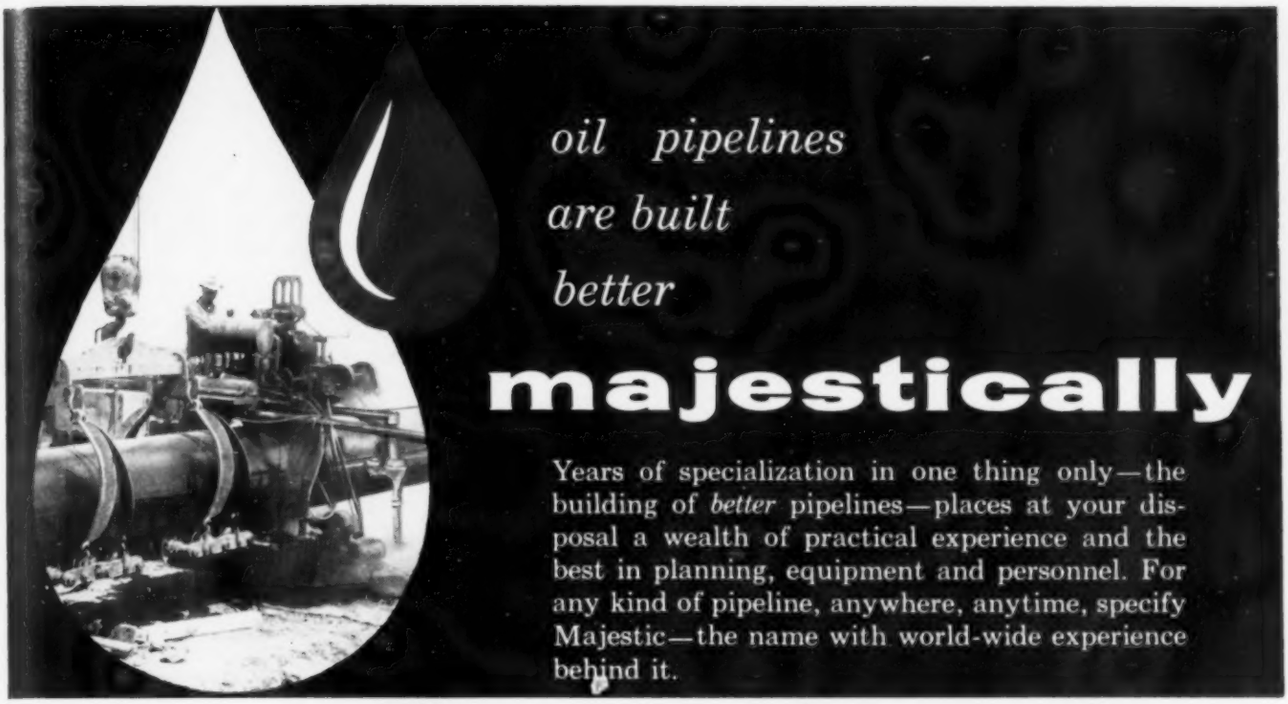
For more data, circle **No. E9** on Readers' Service Card, last page this issue.

Pipe Wrap Tape

Permacel has announced the availability of a new polyethylene pipe wrap tape designated Permacel 308. The underground pipe covering is 12.5 mils thick.

The rugged durable polyethylene backing is resistant to water, acids, alkalies, solvents, salt water, oil and fungus growth. The tape also can be used as an electrical insulation tape.

For more data, circle **No. E10** on Readers' Service Card, last page this issue.



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Years of specialization in one thing only—the building of *better* pipelines—places at your disposal a wealth of practical experience and the best in planning, equipment and personnel. For any kind of pipeline, anywhere, anytime, specify Majestic—the name with world-wide experience behind it.

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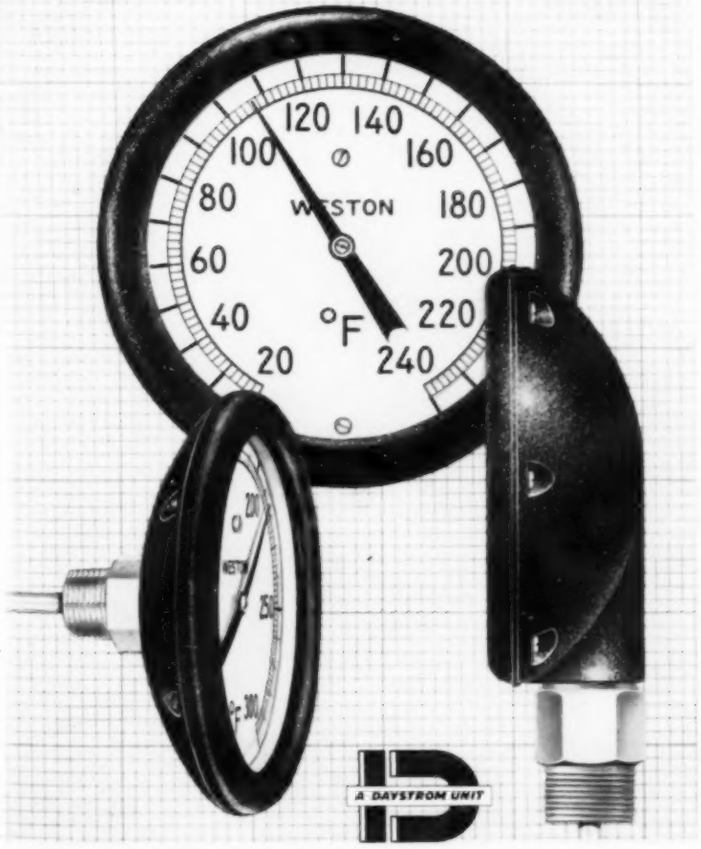

WESTON HEAVY-DUTY BIMETALS:

Proved under industry's most punishing conditions:

Wherever thermometry is critical or unusually demanding you can specify *Weston* with confidence. You have at your disposal a full line of the most rugged, stable, sensitive instruments ever designed for strenuous service.

Weston Heavy-Duty Bimetal Thermometers offer exceptionally reliable sensitive elements...corrosion-proof, pressure-tested stainless steel stems and connection nuts . . . abuse-proof forged brass heads . . . unusually large, readable scales. Accuracies within 1% of full scale range are assured. 20 standard ranges are available–covering an area from –100° to 1000° F. or –100° to 400° C. Standard stem lengths from 2½" to 72"; scale lengths of 9" and 12".

Catalog 09-100 contains full information. Contact your local Weston representative, or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

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RIVERWEIGHTS

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PIPELINE OPERATIONAL EFFICIENCY *and cost reductions can be effected . . . without cost . . . simply by reading Briggs' new Lube Oil Booklet* "LUBRICATING OIL FILTRATION"

This fully illustrated "briefed-for-quick reading" eight page booklet tells how the five accepted filtration systems can and should be used for top performance of equipment. It points up the ways and means to get the most out of the filter cases you now have. You can put much of the information to work right away.

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AIR/GAS LINE FILTERS

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- FILTER/SEPARATORS
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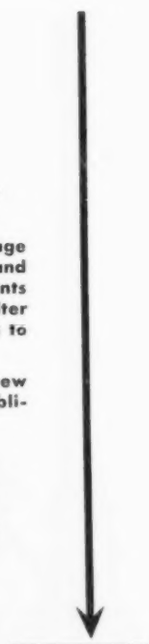

THE BRIGGS FILTRATION CO. DEPT. 287 WASHINGTON 16, D. C.
Send the two pieces of descriptive literature as described.

NAME_____

COMPANY_____

ADDRESS_____

Pressure Switch

Barksdale Valves announces a new pressure difference switch particularly suitable for filter installation.

Constructed to sense a difference from 5 psi to 140 psi between two filters, the switch senses the pressure difference across the filter's inlet and outlet and actuates a warning circuit. A sealed piston sensing element actuates an electric circuit upon increasing or decreasing of a predetermined pressure difference. It is applicable to oil systems ranging from 50 psi to 6,000 psi working pressure. A high proof pressure rating of 9,000 psi gives protection against damage from sudden surges and shock loads.

For more data, circle **No. E11** on Readers' Service Card, last page this issue.

Rubber-Tired Sideboom

A new sideboom for use on rubber-tired tractors has been placed on the market by Midwestern Manufacturing Company. The boom has a lifting capacity of 7,000 pounds with all-hydraulic operation and a friction clutch for free spooling the load line. A counterweight can be extended to increase stability on rough terrain or with heavy loads.

(This item supplements Midwestern Manufacturing Company data on page 292 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E12** on Readers' Service Card, last page this issue.

Dependable

SACHSE ELECTRIC INC.
BATON ROUGE LA.

PIPELINES
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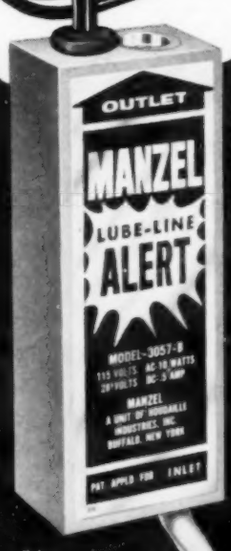
FLOW-actuated alarm



LUBE-LINE ALERT gives positive protection to valuable compressors, engines, machinery and other equipment using force feed lubrication. Small, compact precision-made FLOW alarm inserts into oil lines near each terminal point.

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- Connects electrically to any signal—horn, buzzer, light, whistle, telephone, relay
- Signals LACK OF FLOW through line
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- Handles any viscosity oil or synthetic
- Pressures to 10,000 psi in standard models
- Explosion-proof units available

***FREE** Specification Sheet gives complete details. Write for your copy.*

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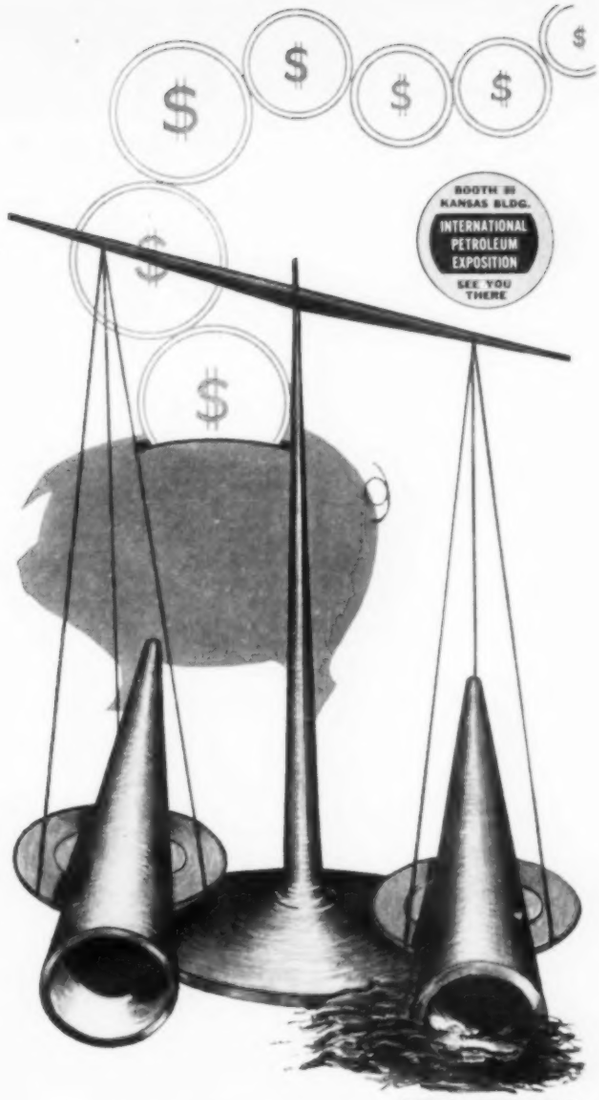

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Lightweight pipe from Cal-Metal Pipe costs less to buy, less to lay, less to ship . . . stays in service l-o-n-g-e-r.

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Sizes:
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BrakeSol is the most effective chemical for treating all types of paraffin conditions. It is approved by refiners . . . contains no chlorinated solvents or other organic halides or sulphides. Contact your nearby BrakeSol Treating Engineer or Supply Store for information on how your paraffin problems can be eliminated economically.

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TODAY THE E/4 SHOULDER HOLIDAY DETECTOR AND THE E/P PULSE TYPE DETECTOR FOR DAMP CLIMATES ARE ANSWERING THE PIPELINER'S NEED FOR A DEPENDABLE, FULLY PORTABLE, GENERAL PURPOSE, ELECTRICAL INSPECTION INSTRUMENT.

BOTH MODELS CAN BE USED FOR A FULL DAY WITHOUT RECHARGING THE BATTERY. ALL WRAPPED SURFACES INCLUDING PIPE CAN BE QUICKLY AND ACCURATELY INSPECTED FOR VOIDS, PINHOLES, BREAKS, SCRATCHES AND BURNED OR COKED SPOTS

TOMORROW THESE SAME DETECTORS WILL BE USED IN THE INSPECTION OF TUBING ON OUTER SPACE ROCKETS. FOR TINKER & RASOR DETECTORS ARE DESIGNED FOR THE FUTURE.

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New Equipment Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card.

Fluid Proportioning

A bulletin explaining B-I-F Industries, Inc.'s proportioneers Model 1106 Adjust-O-Feeder has been announced.

Designed for accurate proportioning of general industrial fluids, this versatile pump, in either simplex or duplex styles, has the important stroke adjustment in motion features as an optional extra.

The two-page bulletin contains photographs of the simplex and duplex models, and a capacity table listing capacity in gph, maximum discharge pressure in psig, plunger diameter in inches, stroke length in inches and strokes per minute.

To get a copy, circle **No. E13** on Readers' Service Card, last page this issue.

Gate Valves

Pipe line gate valves are covered in a new catalog published by Grove Valve and Regulator Co. It is complete with dimension drawings and dimension figures on all Grove's G-3 valves.

The valves are available in 2, 3 and 4-inch sizes in all the ASA series of 150, 300, 400, 600 and 900 valves. These are available with either welded ends or flanged ends.

To get a copy, circle **No. E14** on Readers' Service Card, last page this issue.

Temperature Detection

How to obtain reliable, low-cost temperature detection with Edison's Omniguard is described in a 30-page catalog released by Instrument Division of Thomas A. Edison Industries.

A section of the catalog contains complete information about Edison resistance temperature detectors, used in aircraft and industries where temperatures are measured. Description of models 310 monitor unit and 311 indicator, details of operation, specifications, connections, installations and other information on the Omniguard are featured.

To get a copy, circle **No. E15** on Readers' Service Card, last page this issue.

Ironcase Meters

American Meter Company has published a brochure featuring its 25B and 35B ironcase meters. The bulletin provides complete details on the capacities, construction, and performance of both meters.

Both meters can be used with sewage gas, acetylene, oxygen and other special services.

To get a copy, circle **No. E16** on Readers' Service Card, last page this issue.

Precision Gears

High performance, precision gears are described in detail in General Electric's 22-page bulletin. The bulletin points out that from the simplest to the most complex arrangements, General Electric designs and develops new and special units and combines skilled manpower and modern manufacturing techniques in construction.

The bulletin also discusses allied products such as various gear testing devices and high-speed flexible couplings.

To get a copy, circle **No. E17** on Readers' Service Card, last page this issue.

Tractor Film

Caterpillar Tractor Co. has released a color motion picture titled "The New D8 Series H."

The film follows development of the new tractor from the engineer's drawing boards through research testing at proving grounds and on-the-job sites. Important new features of the series are covered to show how performance and design have been improved.

To get a copy, circle **No. E18** on Readers' Service Card, last page this issue.

Engine Reconditioning

Caterpillar Tractor Co. has released an eight-page bulletin on "Money Saving Hints on Engine Reconditioning," which gives several tips on various operations which are necessary in reconditioning engines.

The two-color booklet is highly illustrated with photographs and drawings. It includes sections on valves, pistons and rings, and piston liners.

To get a copy, circle **No. E19** on Readers' Service Card, last page this issue.

Resistance Recorders

A one-page flier has been published by Leeds & Northrup Company describing the company's new speedomax H resistance ratio recorders. Utilizing a ratio form of wheatstone bridge circuit, the speedomax recorder is designed to operate with transducers having a total resistance between 1,000 and 10,000 ohms.

The bulletin points out features and specific data of the unit and includes illustrations of three different models.

To get a copy, circle **No. E20** on Readers' Service Card, last page this issue.

Level Controller

Details of a compact pneumatic-electronic control device to detect and control changes in media level are given in a bulletin published by Aeronautical and Instrument division of Robertshaw-Fulton Controls Company.

Consisting of a capacitance-sensitive probe and a controller, the pneutronic level controller comprises a complete system for level control in a variety of liquid and granular media through pneumatic pressure output. It is obtainable with weather tight or explosion proof control housings, and types are available for either overload or underload control.

To get a copy, circle **No. E21** on Readers' Service Card, last page this issue.

This report helps you save on pump-station maintenance

Here's a new Oakite Service Report – free, of course – on maintenance cleaning at the pipeline pumping station.

It's full of valuable, time-saving ideas ... any one of which might turn out to give you a deep cut in maintenance costs. You'll find helpful shortcuts on:

- Engine room maintenance
- Lube oil cooler maintenance
- Cleaning electric motors, generators, control panels, etc.
- Paint stripping
- Storage tank cleaning
- Cleaning crude and natural gas lines

FREE. Write for a free copy of this Oakite Service Report No. B6878. Address Oakite Products, Inc., 51A Rector Street, New York 6, N.Y.

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or

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AMAZING U.S.

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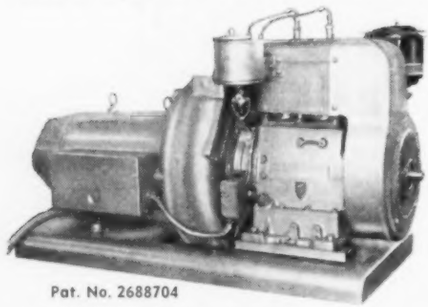

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ACTS...

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SAVES...

. . . UP TO $300 PER MILE on new Micro Wave installations. Just one compact Micro-Power Unit replaces a costly array of complicated equipment.

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See our operating Micro-Power exhibit, Space 202, North Area, at International Petroleum Exposition, Tulsa, May 14-23.

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Quoted from Mr. Dillard Stokes' Column, Shreveport Journal, Oct. 13, 1958.

"President Washington, who spoke of usurpation, said in his Farewell Address: 'If in the opinion of the people, the distribution of the Constitutional powers be in any particular wrong, let it be corrected by an amendment . . . but let there be no change by usurpation; for . . . this is the customary weapon by which free governments are destroyed' "

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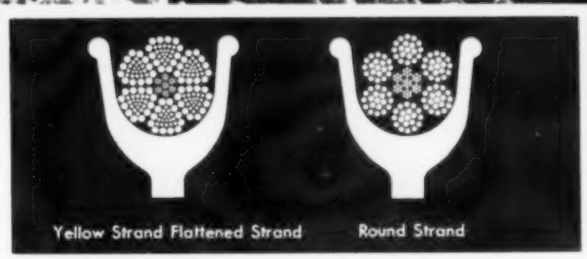
SEE YOUR NEAREST SUPPLY HOUSE



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CUTS WIRE ROPE COSTS 50% ON TOUGH BACKFILL JOB

This was a tough one. Wide ditch – heavy, wet dirt – high line speeds over a short distance – severe reverse rope bend – an extra large bucket. Rapid wear and fatigue actually tore apart ordinary round strand rope to the tune of five to seven 50′ lengths per day. Then Houston Contracting Company selected Yellow Strand Flattened Strand Wire Rope. Now, one length per day is used in place of five to seven. They cut rope costs by 50%, saved substantially in man-hours and machine down time.

What made the difference? Compare the two illustrations above: See how each strand of Yellow Strand Flattened Strand is laid up in a triangular pattern. Contact with the sheave groove is made by *many* wires instead of just a few. Note the marked increase in compactness in the Flattened Strand, with greater crush resistance and 10% greater metallic area. This is the design that makes ropes, sheaves and drums last longer! For complete details about Yellow Strand Flattened Strand, contact your distributor or check with us. Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo.

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Unicor prevents corrosion in pipelines—keeps pipelines free of scale. With Unicor you are assured of maintaining maximum flow capacity, C factor and output.

2. Reduce downtime

Downtime to scrape lines and replace filters is production time lost. Prevent such loss with Unicor. It keeps equipment free of products of corrosion.

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